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INTERIM REPORT
April 23, 1993

FOR

BIOVENTING FIELD INITIATIVE

AT

GALENA AND CAMPION AIR FORCE STATIONS, ALASKA

to

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BIOVENTING FIELD INITIATIVE

GALENA AND CAMPION AIR FORCE STATIONS, ALASKA

1.0 INTRODUCTION

This report describes the activities conducted at Galena Air Force Station (AFS) and Campion AFS, Alaska, as part of the Bioventing Field Initiative for the U.S. Air Force Center for Environmental Excellence (AFCEE) and the Environmental Quality Directorate of the Air Force Armstrong Laboratory. This report summarizes the results from the first phase of the study at Galena AFS and Campion AFS. First-phase activities include a soil gas survey, air permeability test, in situ respiration tests, and installation of bioventing systems. The specific objectives of this Bioventing Field Initiative are described in the following section. Each site at the base is discussed individually, followed by a description of site activities at the background area.

1.1 Objectives

The purpose of this Bioventing Field Initiative is to measure the soil gas permeability and microbial activity at a contaminated site in order to evaluate the potential application of bioventing technology to remediate the site. The specific test objectives are stated below.

- A small-scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system. Soil gas from the candidate site should exhibit high total petroleum hydrocarbon (TPH) concentrations, relatively low oxygen concentrations, and relatively high carbon dioxide concentrations. An uncontaminated background location also will be identified.

- The soil gas permeability of the soil and the air vent (well) radius of influence will be determined. To measure these parameters, air will be withdrawn or injected for approximately 8 hours at vent wells located in contaminated soils. Pressure changes will be monitored in an array of monitoring points.

- Immediately following the soil gas permeability test, an in situ respiration test will be conducted. Air will be injected into selected monitoring points to

aerate the soils. The in situ oxygen utilization and carbon dioxide production rates will be measured.

- The data from the soil gas permeability and in situ respiration tests will be used to determine an air injection/withdrawal rate for the bioventing test. A blower will be selected, installed, and operated for 6 to 12 months, and periodic measurements of the soil gas composition will be made to evaluate the long-term effectiveness of bioventing.

1.2 Site Description

Galena AFS is located approximately 280 miles west of Fairbanks, Alaska, on the Yukon River. The installation is a forward operating base of the U.S. Air Force Alaska Air Command. Approximately 350 military personnel currently are assigned to the base. The population of the adjacent community of Galena is approximately 750. Galena is not connected by road to any other community and is accessible only by air or water.

Campion AFS, located approximately 12 miles east of Galena, was deactivated and demolished in the early to mid-1980s. The site is accessible by gravel road from Galena AFS. No buildings remain, and electrical power currently cannot be accessed at the site.

Descriptions of the sites at Galena and Campion AFS are given in the following sections. A detailed description is provided in the Test Plan in Appendix A.

1.2.1 Saddle Tank Farm Site (Galena)

The Saddle Tank Farm Site is located east of tanks 37 and 38. The tank farm contains approximately 20 aboveground petroleum storage tanks in a diked area (Figure 1). Groundwater at the site typically is encountered at less than 10 feet beneath the surface, although measurements taken during system installation showed depths of 15 to 17 feet. This site is located several hundred feet from a vapor extraction pilot study being conducted by Radian Corporation. Soil analytical data have not been made available for this site.

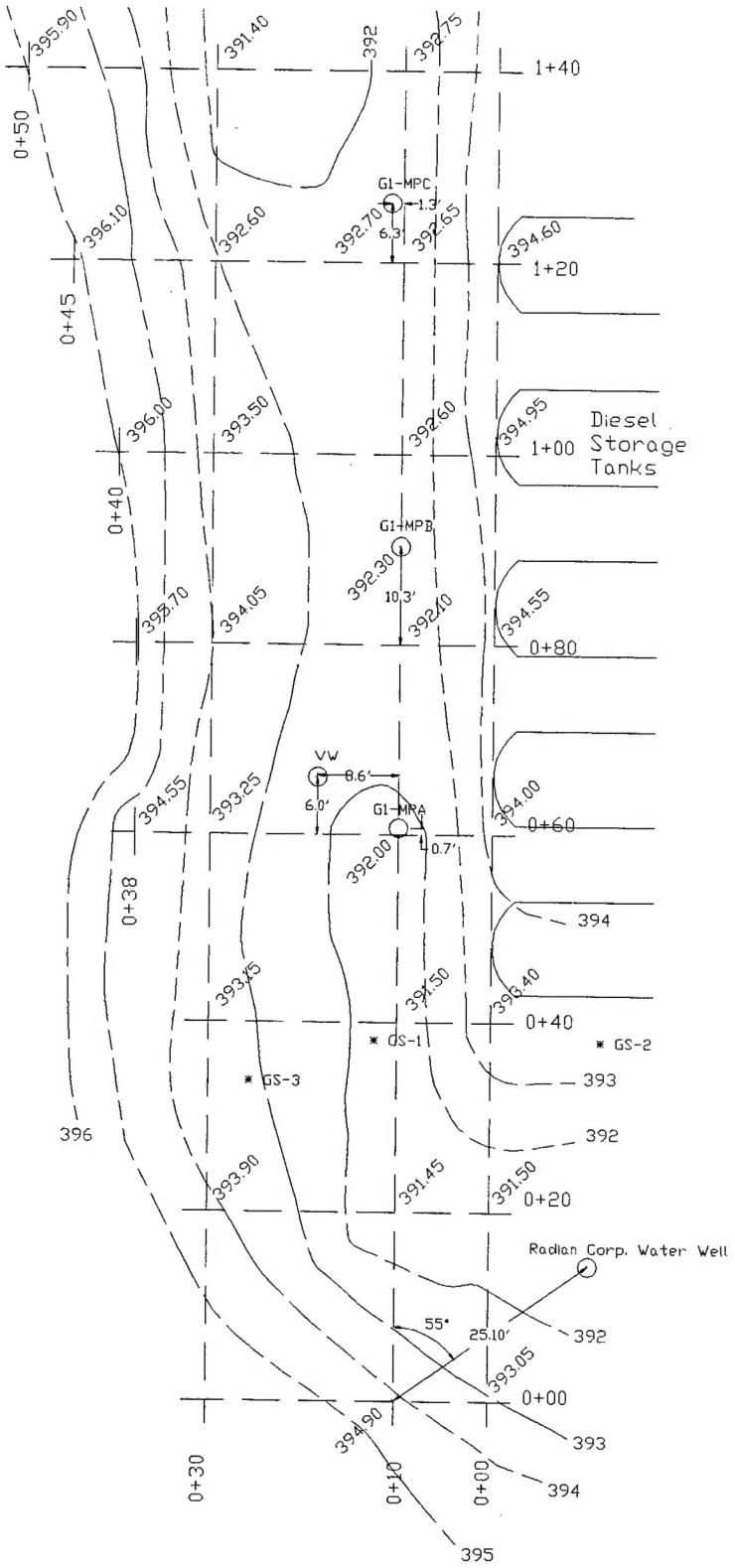

Figure 1. Schematic Diagram of Saddle Tank Farm Site at Galena AFS (GS - Soil Gas Survey Point; MP - Monitoring Point)

1.2.2 Power Plant Site (Galena)

The Power Plant Site is a 20,000-gallon diesel tank located adjacent to the base power plant (Figure 2). Groundwater is encountered at approximately 10 feet beneath the surface at the site. Soil analytical data have indicated TPH concentrations in excess of 10,000 ppm.

1.2.3 Million Gallon Hill Site (Galena)

Tanks 37 and 38 are large-capacity aboveground petroleum storage tanks containing diesel fuel and JP-4 jet fuel, respectively (Figure 3). The tanks are located in a fuel storage tank farm along with JP-4 jet fuel storage tanks 41 and 42. The tank farm is located on a fill mound built up approximately 30 feet above grade. Groundwater is located at approximately 40 feet below the tanks. Soil analytical data indicate that contamination is encountered primarily at depths greater than 20 feet.

1.2.4 Petroleum, Oil, and Lubricants (POL) Tank Site 1 (Campion)

Campion POL Tank Site is located in the former petroleum storage tank farm at Campion AFS (Figure 4). The tanks have been removed, but their former location is evidenced by circular gravel pads inside a diked area. Soil samples from the site have indicated TPH concentrations of 300 to 500 mg/kg. Groundwater at the site is present at approximately 10 feet beneath the surface.

2.0 SADDLE TANK FARM SITE

2.1 Chronology of Events and Site Activities

2.1.1 Groundwater Measurements

Groundwater was measured at three wells: DTP, DTW, and DTB at the Saddle Tank Farm Site. The depths measured were 15.8 feet (Well DTP), 16.55 feet (Well DTW), and 30.26 feet (Well DTB).

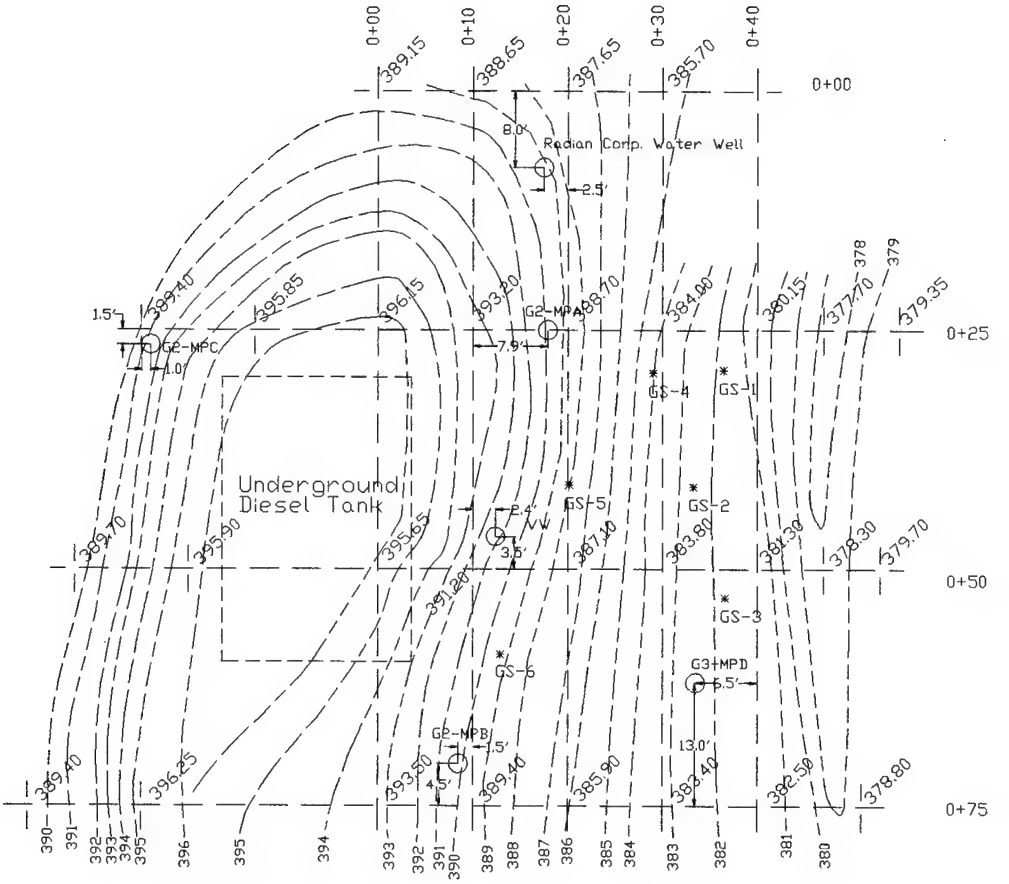

Figure 2. Schematic Diagram of Power Plant Site at Galena AFS (GS - Soil Gas Survey Point; MP - Monitoring Point)

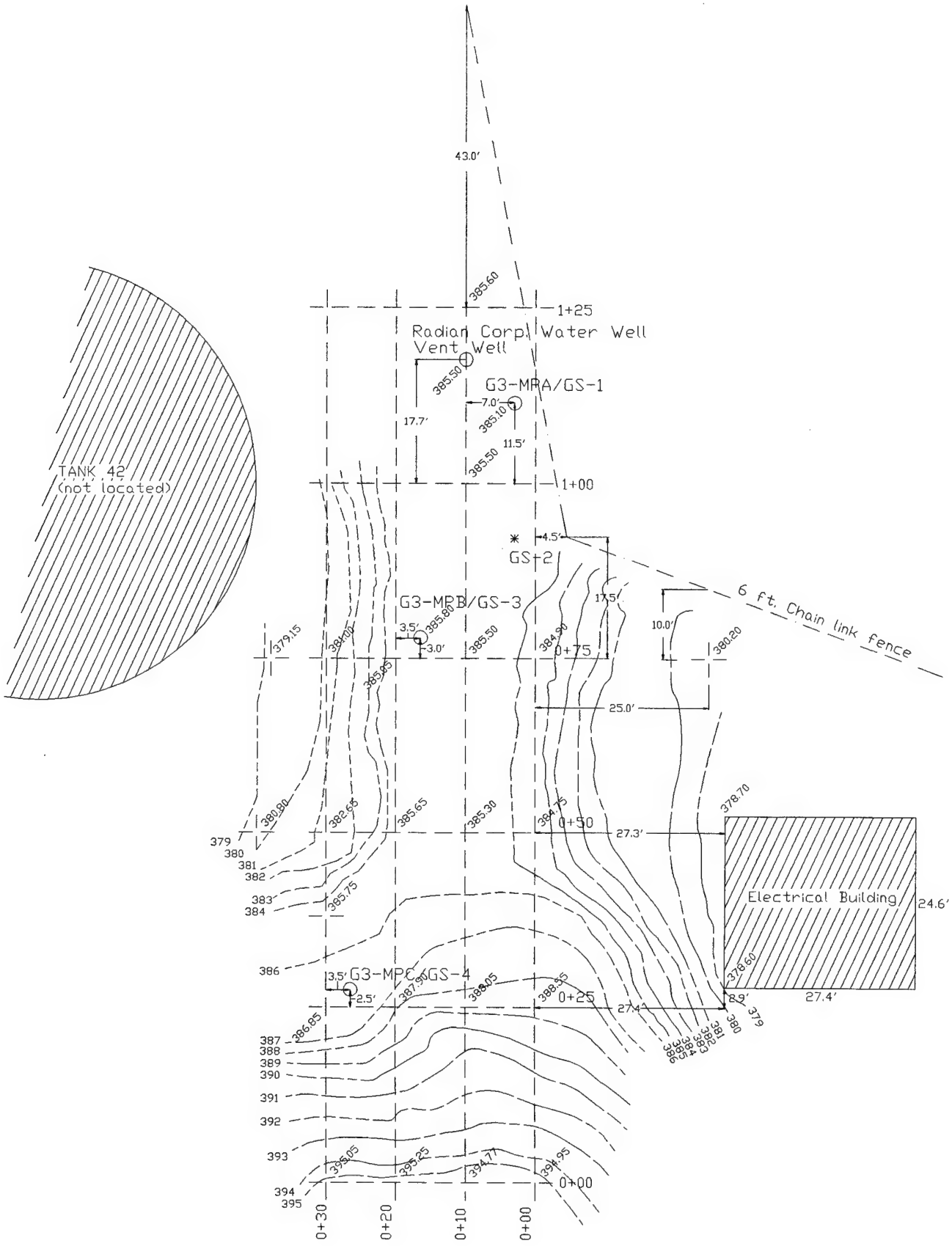

Figure 3. Schematic Diagram of Million Gallon Hill Site at Galena AFS (GS - Soil Gas Survey Point; MP - Monitoring Point)

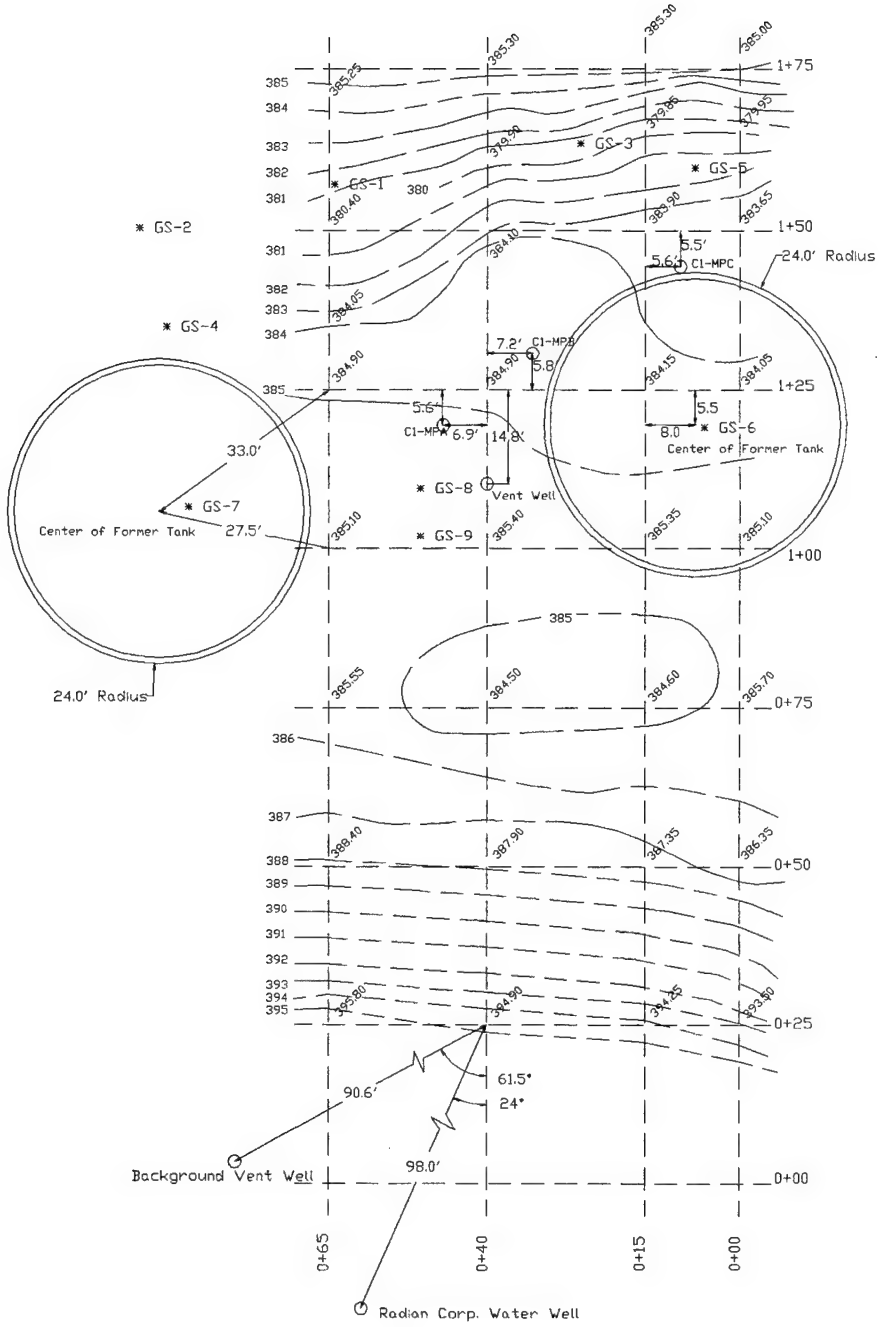

Figure 4. Schematic Diagram of POL Tank Site at Campion AFS (GS - Soil Gas Survey Point; MP - Monitoring Point)

2.1.2 Soil Gas Survey

A suitable site for the bioventing demonstration should have soil gas characteristics of high TPH, low oxygen, and high carbon dioxide concentrations. This composition of soil gas would indicate that oxygen-limiting conditions for microbial activity are present and that the introduction of air may enhance biodegradation of TPH.

On August 17, 1992, a limited soil gas survey was conducted at the area recommended by the point-of-contact (POC) at the Saddle Tank Farm Site. Soil gases were sampled by driving a ⅝-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and was analyzed for oxygen, carbon dioxide, and TPH.

Measurements of oxygen and carbon dioxide in the soil gas were made with a GasTech Model 32520X with oxygen and carbon dioxide ranges of 0 to 25%. The analyzer was calibrated daily against atmospheric oxygen, atmospheric carbon dioxide, a 10% oxygen calibration standard, and a 5% carbon dioxide calibration standard. TPH was measured with a GasTech Trace Techtor with TPH ranges from 0 to 100, 0 to 1,000, and 0 to 10,000 ppm. The GasTech Trace Techtor was calibrated daily against a 4,200-ppm hexane standard.

The soil gas probes were driven to depths ranging from 2.5 to 7.5 feet at several locations at the Saddle Tank Farm Site. Once groundwater was encountered, the probes were not driven deeper. Table 1 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at the Saddle Tank Farm Site. Oxygen concentrations varied from 4.0 to 18.0%, and TPH concentrations ranged from 90 to 3,600 ppm. In general, the oxygen concentrations tended to decrease with increasing depth, whereas TPH tended to increase with increasing depth. The oxygen results indicate that some areas at this site are oxygen-limited and may respond to bioventing.

2.1.3 Vent Well, Monitoring Point, and Thermocouple Installation

On August 20, 1992, one vent well and three monitoring points were installed, and soil samples were collected for analyses at the Saddle Tank Farm Site. The monitoring points (MP) were labeled as follows: G1-MPA; G1-MPB; and G1-MPC. The locations of the vent well and monitoring points are shown in Figure 1. A cross section of the vent well and monitoring points showing site lithology and construction detail is shown in Figure 5.

Table 1. Initial Soil Gas Composition at the Saddle Tank Farm Site

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	2.5	16.5	4.1	90
	5.0	4.0	18.0	1,600
	7.5	5.0	10.0	3,600
GS-2	2.5	18.0	2.5	90
GS-3	2.5	3.0	9.0	90

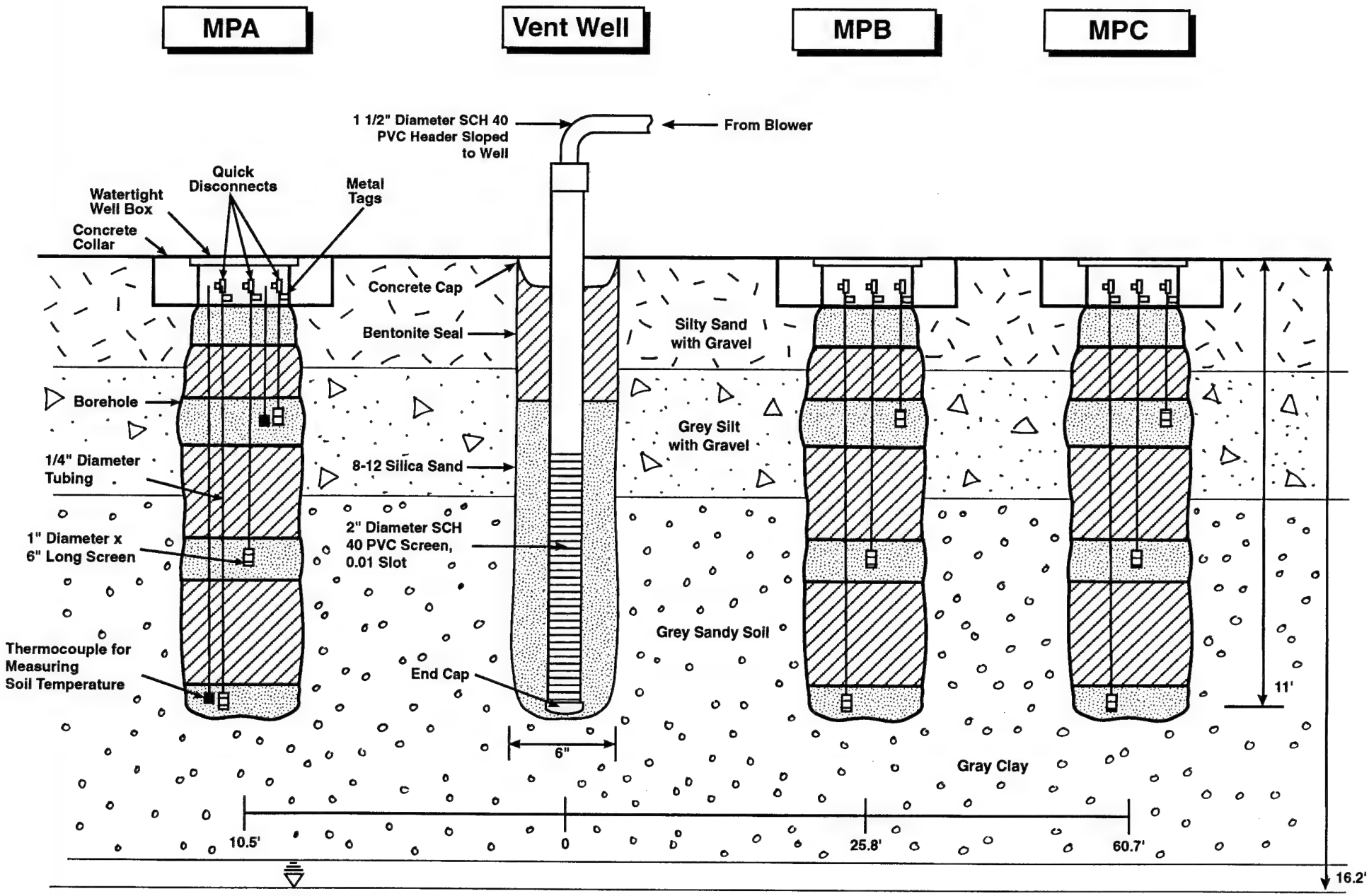

Figure 5. Cross Section of Vent Well and Monitoring Points at the Saddle Tank Farm Site Showing Site Lithology and Construction Detail (not to scale)

F/Leeson/GA1

The vent well was installed at a depth of 11.0 feet into a 6-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter polyvinyl chloride (PVC) piping with 7.5 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, and the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil gas probes consisted of ¼-inch tubing with a 1-inch-diameter, 6-inch screened area. The annular space corresponding to the screened area was filled with silica sand, whereas the interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. All monitoring points were installed at a depth of 11.0 feet into an 8-inch-diameter borehole and screened to three depths: 4.0, 7.5, and 11.0 feet.

A Type J thermocouple was installed with monitoring points G1-MPA-4.0′ and G1-MPA-11.0′.

2.1.4 Soil and Soil Gas Sampling and Analyses

Soil samples were collected at the Saddle Tank Farm Site at depths of 2.5 to 3.0 feet, 5.5 to 6.0 feet, and 8.0 to 8.5 feet from the vent well borehole and were labeled GA1-V-2.5, GA1-V-5.5, and GA1-V-8.0, respectively. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of benzene, toluene, ethylbenzene, and xylenes (BTEX); TPH; alkalinity; moisture content; pH; iron; total phosphorous; and total Kjeldahl nitrogen.

Soil gas samples also were collected from the vent well and from monitoring points G1-MPA and G1-MPC, and these were labeled vent well, MPA red, and MPC red. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analysis of BTEX and TPH.

2.1.5 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute k, the soil gas permeability, is given in the Test Plan and Technical Protocol (Hinchee et al., 1992).

Prior to air injection at the Saddle Tank Farm Site, the monitoring points were allowed to set up for 96 hours. Air was injected with a portable 1-horsepower (HP) explosion-proof positive

displacement blower unit. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The Hyperventilate™ computer model was used to calculate the soil gas permeability.

2.1.6 In Situ Respiration Test

Immediately following the soil gas permeability test at the Saddle Tank Farm Site, air containing approximately 1% helium was injected into the soil for approximately 20 hours, beginning on August 25. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test is described by the Test Plan and Technical Protocol (Hinchee et al., 1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through the following monitoring points at the depths indicated: G1-MPA-4.0′; G1-MPA-7.5′; G1-MPB-7.5′; and G1-MPC-11.0′. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on August 28.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributed to either diffusion or leakage. A rapid drop in helium concentration followed by a leveling is an indication of leakage. A gradual loss along with an apparent first-order curve is an indicator of diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium gas diffuses about 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations are at least 50% to 60% of the initial levels at test completion, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

To compare data from one site to another, a stoichiometric relationship of the oxidation of the hydrocarbon was assumed. Hexane was used as the representative hydrocarbon for the organic contaminant. The stoichiometric relationship is given by:

$$C_6H_{14} + 9.5O_2 \rightarrow 6CO_2 + 7H_2O \qquad (1)$$

Based on the utilization rates (% per day), the biodegradation rates in terms of mg as a hexane equivalent per kg of soil per day were computed using the equation below by assuming a soil porosity of 0.2 and a bulk density of 1,440 kg/m^3.

$$K_\beta = \frac{-K_o A D_o C}{100} \qquad (2)$$

where: K_β = biodegradation rate (mg/kg/day)

K_o = oxygen utilization rate (percent per day)

A = volume of air/kg of soil, in this case 300/1,440 = 0.21

D_o = density of oxygen gas (mg/L) assumed to be 1,330 mg/L

C = mass ratio of hydrocarbon to oxygen required for mineralization, assumed to be 1/3.5 from the above stoichiometric equation.

2.2 Results and Discussion

2.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH at the Saddle Tank Farm Site are presented in Table 2. The analytical report for this site is presented in Appendix B. Concentrations of the BTEX compounds in soil samples ranged from below the detection limit (benzene and ethylbenzene) up to 3 mg/kg (total xylenes), whereas TPH concentrations ranged from 85 to 420 mg/kg. The soil gas analyses also showed similar measurements of BTEX and TPH, with concentrations of TPH ranging from 36 to 6,700 ppmv and from less than 0.11 ppmv (benzene) up to 120 ppmv (benzene) (Table 2). The results of the soil chemistry analyses are summarized in Table 3.

2.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at the Saddle Tank Farm Site are presented in Appendix C. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data are presented in Table 4. The soil gas permeability varied

Table 2. Results From Soil and Soil Gas Analyses for BTEX and TPH at the Saddle Tank Farm Site

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH[1] (mg/kg)
Soil	GA1-V-2.5	<0.075	1.0	<0.063	1.2	420
	GA1-V-5.5	<0.080	0.42	<0.066	3.0	300
	GA1-V-8.0	<0.076	0.48	<0.063	0.96	85
Matrix	**Sample Name**	**Benzene (ppmv)**	**Toluene (ppmv)**	**Ethylbenzene (ppmv)**	**Total Xylenes (ppmv)**	**TPH[2] (ppmv)**
Soil Gas	Vent well	0.3	0.084	0.034	0.12	36
	MPA red	120	22	6.8	18	6,700
	MPC red	<0.11	2.9	1.3	0.97	1,500

[1] Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.
[2] TPH referenced to gasoline (molecular weight = 100).

Table 3. Results From Soil Chemistry Analyses at the Saddle Tank Farm Site

Parameter	Sample Name		
	GA1-V-2.5	GA1-V-5.5	GA1-V-8.0
Alkalinity (mg/kg $CaCO_3$)	400	670	500
Moisture (% by weight)	20.3	24.8	20.7
pH	7.8	7.4	7.4
Iron (mg/kg)	20,300	24,500	19,500
Total Phosphorus (mg/kg)	670	720	790
Total Kjeldahl Nitrogen (mg/kg)	800	800	800

Table 4. Results of Hyperventilate™ Soil Gas Permeability Analysis at the Saddle Tank Farm Site

Monitoring Point	Depth (ft)	Soil Gas Permeability (darcy)
G1-MPA	4.0	1.7×10^9
	7.5	1.1×10^9
	11.0	7.2×10^8
G1-MPB	4.0	1,500
	7.5	2,400
	11.0	18,000
G1-MPC	4.0	740
	7.5	840
	11.0	890

considerably, with values ranging from 740 to 1.7 x 10^9 darcy. The radius of influence where a pressure of 1 inch of water could be measured was calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the vent well (Figure 6). The radius of influence at the Saddle Tank Farm Site is approximately 43 feet.

2.2.3 In Situ Respiration Test

The results of the in situ respiration test for Saddle Tank Farm Site are presented in Appendix D. Each figure in Appendix D illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization at this site is shown in Figure 7, where oxygen utilization and carbon dioxide production at monitoring point G1-MPA-4.0′ are illustrated. A summary of the oxygen utilization and carbon dioxide production rates and corresponding biodegradation rates is shown in Table 5. The biodegradation rates measured at this site were fairly high, with rates ranging from 11 to 30 mg/kg/day for oxygen utilization, and from 4.5 to 6.5 mg/kg/day for carbon dioxide production.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were measured during the in situ respiration test. Temperatures during the test ranged from 11.6°C to 12.9°C at monitoring point G1-MPA-4.0′ and from 4.4°C to 5.6°C at monitoring point G1-MPA-11.0′.

2.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at Saddle Tank Farm Site. The bioventing system will not be installed at this site until spring 1993.

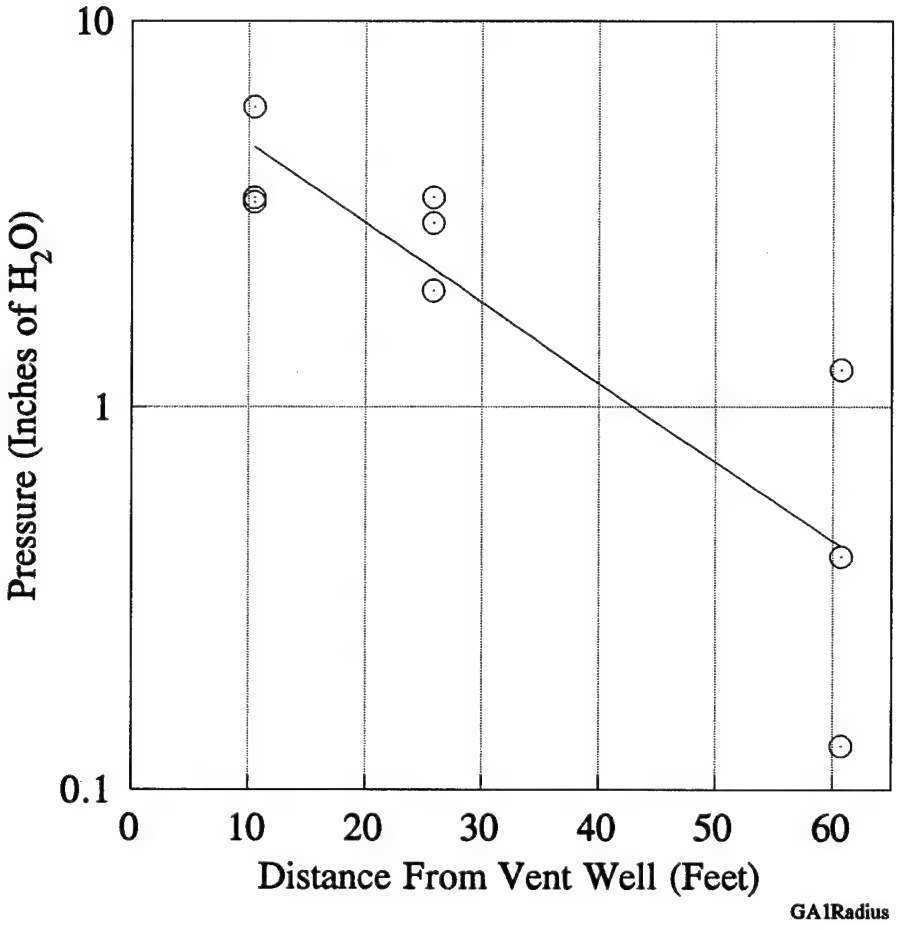

Figure 6. Radius of Influence at the Saddle Tank Farm Site

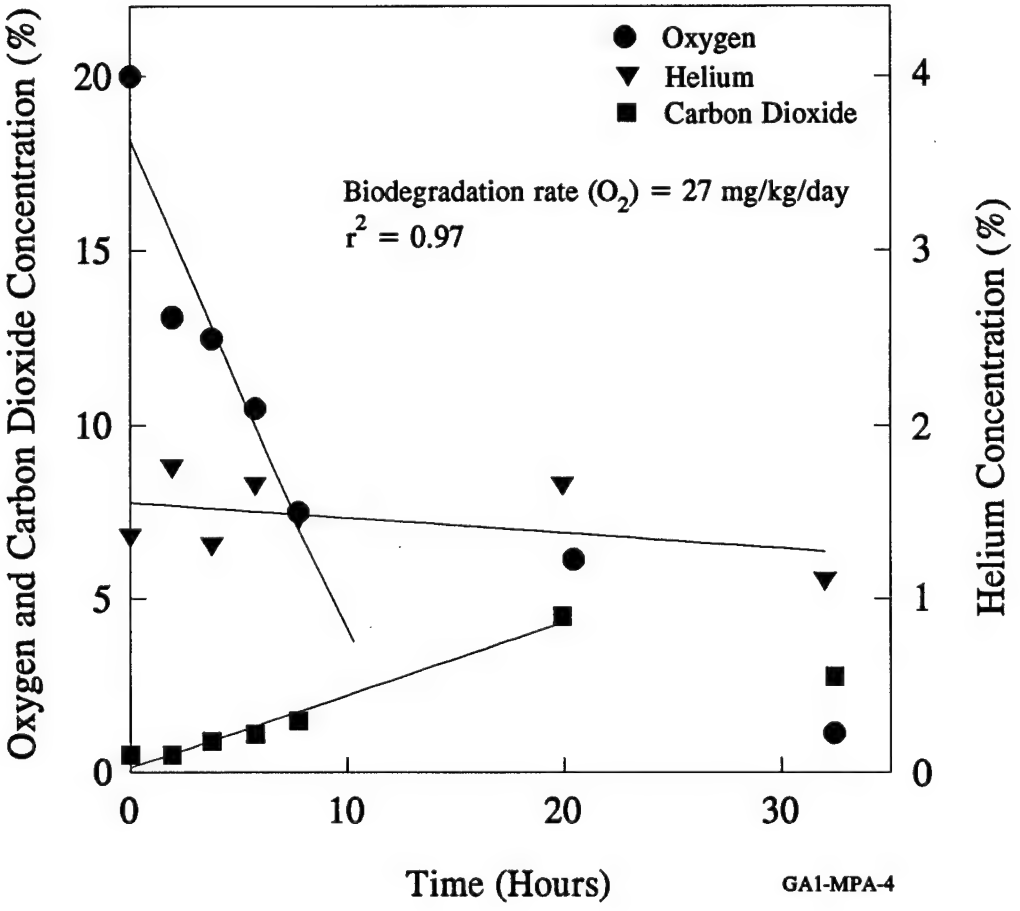

Figure 7. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G1-MPA-4.0′ at the Saddle Tank Farm Site

Table 5. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at the Saddle Tank Farm Site

Sample Name	Oxygen Utilization Rate (%/hour)	Biodegradation Rate (mg/kg/day)	Carbon Dioxide Production Rate (%/hour)	Biodegradation Rate (mg/kg/day)
Background	0.11	2.2	0.079	1.7
G1-MPA-4.0′	1.4	27	0.21	4.5
G1-MPA-7.5′	1.6	30	0.23	4.9
G1-MPB-7.5′	0.60	12	0.30	6.5
G1-MPC-11.0′	0.59	11	0.23	4.9

3.0 POWER PLANT SITE

3.1 Chronology of Events and Site Activities

3.1.1 Groundwater Measurements

Groundwater was measured at one monitoring well at the Power Plant Site. Groundwater was recorded at the monitoring well at 12.23 feet.

3.1.2 Soil Gas Survey

On August 18, 1992, a limited soil gas survey was conducted to locate a suitable test area at Power Plant Site on August 18, 1992. Soil gases were sampled by driving a ⅝-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH. Soil gas measurements were taken as described in Section 2.1.2.

The soil gas probes were driven to depths ranging from 2.5 to 7.5 feet at the several locations at the Power Plant Site. Once groundwater were encountered, the probes were not driven deeper. Table 6 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at Power Plant Site. Relatively low concentrations of oxygen were found at most of the soil gas probes, with concentrations ranging from 0 to 14%. Relatively high concentrations of carbon dioxide (5.1 to 14.9%) and TPH (220 to 2,400 ppm) were encountered. The low concentrations of oxygen indicate that this area may respond to bioventing.

3.1.3 Vent Well, Monitoring Point, and Thermocouple Installation

On August 21, 1992, one vent well and four monitoring points were installed at the Power Plant Site, and soil samples were collected for analyses. The monitoring points were labeled G2-MPA, G2-MPB, G2-MPC, and G2-MPD. The locations of the vent well and monitoring points are shown in Figure 2. A cross section of the vent well and monitoring points showing site lithology and construction detail is shown in Figure 8. Figure 9 is a cross section that illustrates elevation changes.

Table 6. Initial Soil Gas Composition at the Power Plant Site

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	2.5	2.0	14.9	1,200
GS-4	2.5	0	11	2,400
	5.0	0	12	1,720
GS-5	2.5	8.8	8	440
	5.0	5.8	10	440
	7.5	1.2	12	1,480
GS-6	2.5	14	5.1	390
	5.0	10	8	220
	7.5	6.1	9.4	220

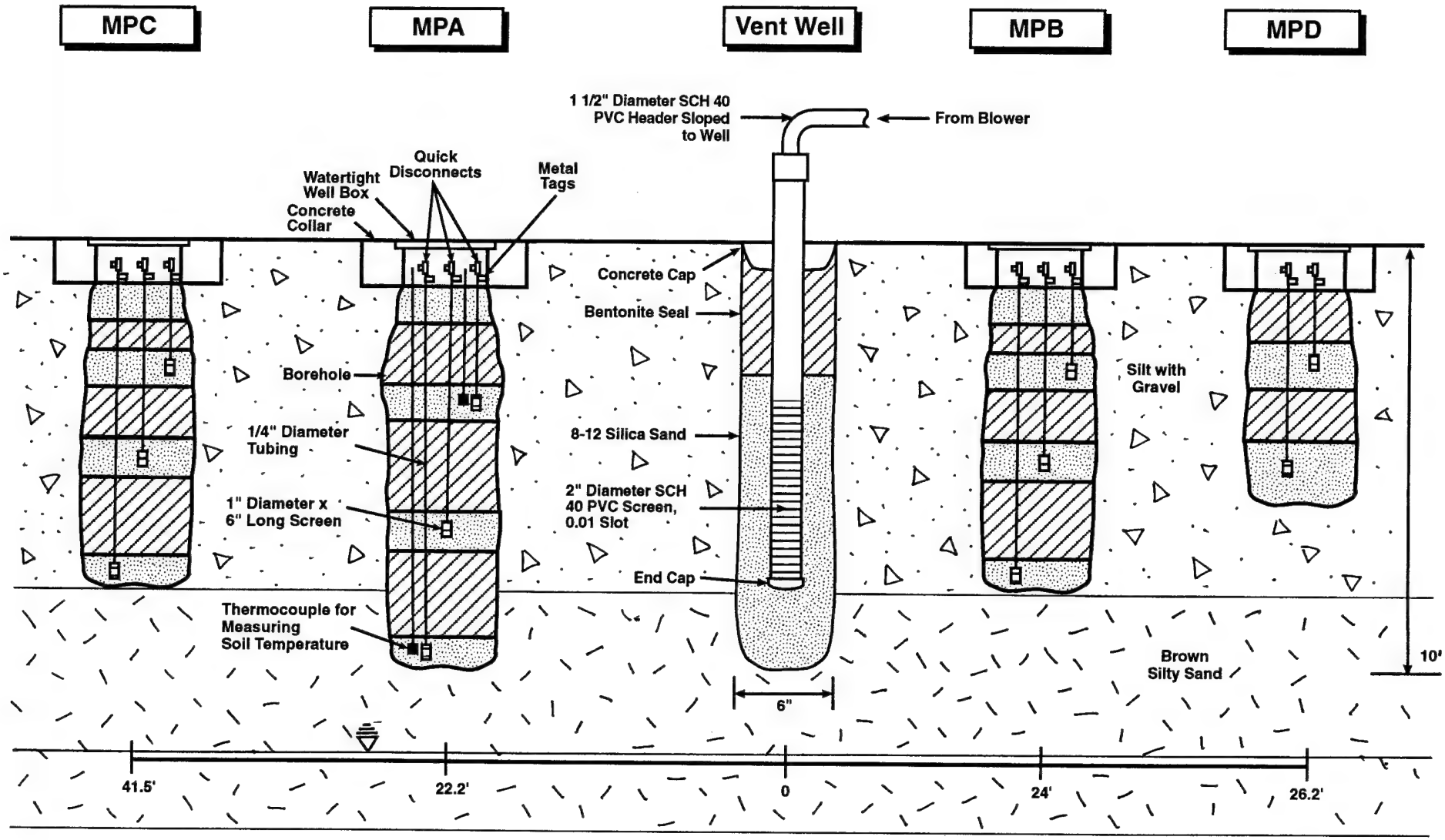

Figure 8. Cross Section of Vent Well and Monitoring Points at the Power Plant Site Showing Site Lithology and Construction Detail (not to scale)

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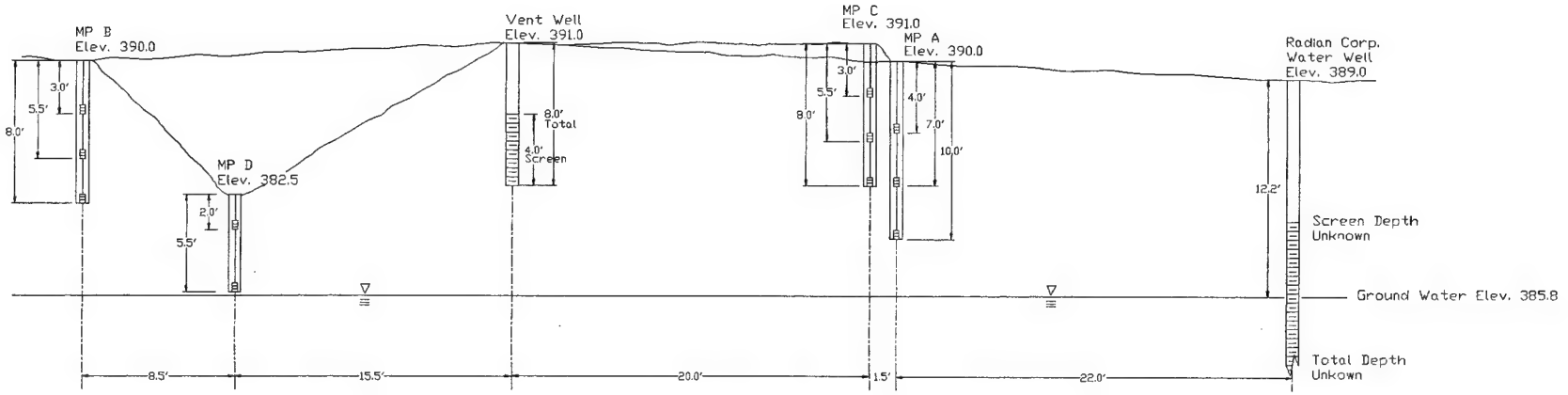


Figure 9. Cross Section of Vent Well and Monitoring Points at the Power Plant Site Showing Elevation Differences

The vent well was installed at a depth of 8.0 feet into a 6-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter PVC piping with 4.0 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, and the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil gas probes consisted of ¼-inch tubing with a 1-inch-diameter, 6-inch screened area. The annular space corresponding to the screened area was filled with silica sand, whereas the interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. The monitoring points were installed at depths as follows:

- Monitoring point G2-MPA was installed at a depth of 10.0 feet into an 8-inch-diameter borehole. The monitoring point was screened to three depths: 4.0, 7.0, and 10.0 feet.
- Monitoring point G2-MPB was installed at a depth of 8.0 feet into an 8-inch-diameter borehole. The monitoring point was screened to three depths: 3.0, 5.5, and 8.0 feet.
- Monitoring point G2-MPC was installed at a depth of 8.0 feet into an 8-inch-diameter borehole. The monitoring point was screened to three depths: 3.0, 5.5, and 8.0 feet.
- Monitoring point G2-MPD was installed at a depth of 5.5 feet into an 8-inch-diameter borehole. The monitoring point was screened to two depths: 2.0 and 5.5 feet.

A Type J thermocouple was installed with monitoring points G2-MPA-4.0′ and G2-MPA-10.0′.

3.1.4 Soil and Soil Gas Sampling and Analyses

Soil samples at the Power Plant Site were collected at depths of 4.0 to 4.5 feet, 5.5 to 5.0 feet, and 11.5 to 12.0 feet from the vent well borehole and were labeled GA2-V-4.0, GA2-V-5.5, and GA2-V-11.5, respectively. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of BTEX, TPH, alkalinity, moisture content, pH, iron, total phosphorous, and total Kjeldahl nitrogen.

Soil gas samples were collected from the vent well and from monitoring points G2-MPA and G2-MPC. These samples were labeled power plant vent well, power plant MPA red, and power plant MPC red, and were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analysis of BTEX and TPH.

3.1.5 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute k, the soil gas permeability, is presented by the Test Plan and Technical Protocol (Hinchee et al., 1992).

Prior to air injection at the Power Plant Site, the monitoring points were allowed to set up for 96 hours. A portable 1-HP explosion-proof positive displacement blower unit was used to inject air. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The Hyperventilate™ computer model was used to calculate the soil gas permeability.

3.1.6 In Situ Respiration Test

Immediately following the soil gas permeability test at the Power Plant Site, air containing approximately 1% helium was injected into the soil for approximately 20 hours, beginning on August 26. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test is described by the Test Plan and Technical Protocol (Hinchee et al., 1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through the following monitoring points at the depths indicated: G2-MPA-10.0′; G2-MPB-5.5′; G2-MPB-8.0′; and G2-MPC-8.0′. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on August 29.

3.2 Results and Discussion

3.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH at the Power Plant Site are presented in Table 7. The analytical report for this site is presented in Appendix B. All of the BTEX compounds were at concentrations below the detection limit in soil samples, whereas TPH concentrations ranged from 51 to 180 mg/kg. The soil gas analyses also showed relatively low BTEX and TPH concentrations with concentrations ranging from 1.1 ppmv (toluene) to 9.1 ppmv (total xylenes) and from 190 to 1,400 ppmv of TPH (Table 7). The results of the soil chemistry analyses are summarized in Table 8.

3.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at the Power Plant Site are presented in Appendix E. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data are presented in Table 9. The soil gas permeability varied considerably, with values ranging from 840 to 7.7 x 10^8 darcy. Typically, the radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the vent well. The radius of influence would then be the distance where 1 inch of water pressure can be measured. However, in this instance, 1 inch of water pressure was not achieved at any monitoring point (Figure 10); therefore, a radius of influence based on these specifications cannot be definitively determined at this site, other than to say it is less than 22 feet.

3.2.3 In Situ Respiration Test

The results of the in situ respiration test for the Power Plant Site are presented in Appendix F. Each figure in Appendix F illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization at this site is shown in Figure 11, where oxygen utilization and carbon dioxide production at monitoring point G2-MPB-8.0′ are illustrated. A summary of the oxygen utilization and carbon dioxide production rates and the corresponding biodegradation rates is shown in Table 10. The biodegradation rates measured at this site were quite high, with rates ranging from 6.2 to 42 mg/kg/day for oxygen utilization, and from 1.9 to 8.0 mg/kg/day for carbon dioxide production.

Table 7. Results From Soil and Soil Gas Analyses for BTEX and TPH at the Power Plant Site

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH[1] (mg/kg)
Soil	GA2-V-4.0	<0.0008	<0.0009	<0.0006	<0.0012	51
	GA2-V-5.5	<0.0008	<0.0006	<0.0012	<0.0009	61
	GA2-V-11.5	<0.0008	<0.0009	<0.0006	<0.0011	180
Matrix	**Sample Name**	**Benzene (ppmv)**	**Toluene (ppmv)**	**Ethylbenzene (ppmv)**	**Total Xylenes (ppmv)**	**TPH[2] (ppmv)**
Soil Gas	Power plant vent well	0.066	0.30	0.35	1.0	190
	Power plant MPA red	<0.11	1.1	1.8	7.4	1,100
	Power plant MPC red	<0.11	2.0	2.0	9.1	1,400

[1] Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

[2] TPH referenced to gasoline (molecular weight = 100).

Table 8. Results From Soil Chemistry Analyses at the Power Plant Site

Parameter	Sample Name		
	GA2-V-4.0	GA2-V-5.5	GA2-V-11.5
Alkalinity (mg/kg $CaCO_3$)	480	500	500
Moisture (% by weight)	23.5	22.6	20.8
pH	7.7	7.8	7.8
Iron (mg/kg)	27,700	19,900	24,900
Total Phosphorous (mg/kg)	750	650	720
Total Kjeldahl Nitrogen (mg/kg)	700	670	490

Table 9. Results of Hyperventilate™ Soil Gas Permeability Analysis at the Power Plant Site

Monitoring Point	Depth (ft)	Soil Gas Permeability (darcy)
G2-MPA	4.0	10
	7.0	3.2×10^{7}
	10.0	1.9×10^{6}
G2-MPB	3.0	7,000
	5.5	4,000
	8.0	320,000
G2-MPC	3.0	7.7×10^{8}
	5.5	$> 1.0 \times 10^{10}$
	8.0	1.2×10^{9}
G2-MPD	2.0	1,400
	5.5	840

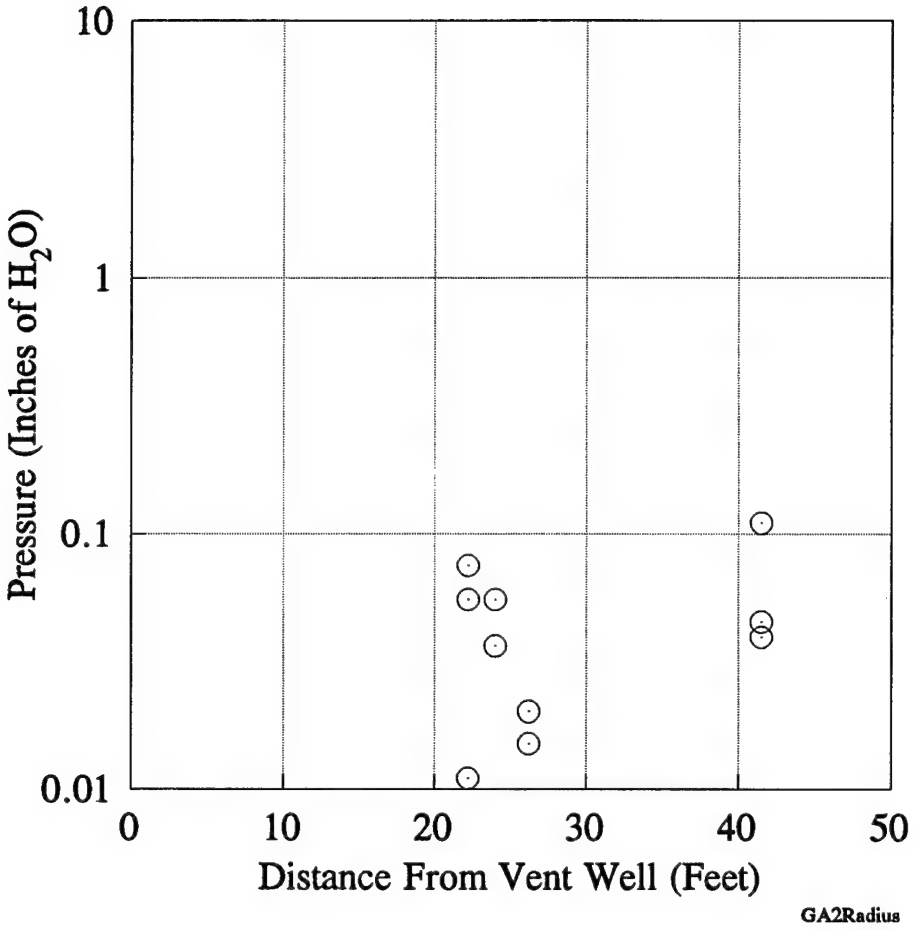


Figure 10. Radius of Influence at the Power Plant Site

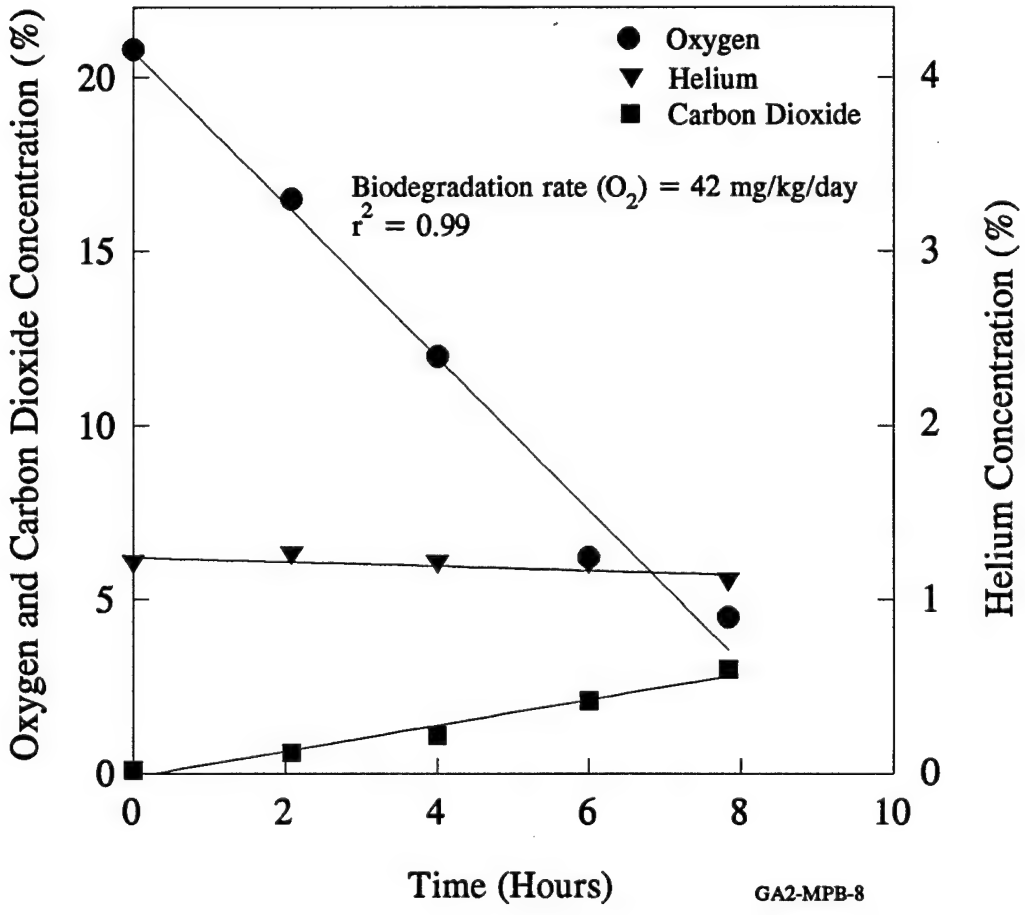


Figure 11. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G2-MPB-8.0′ at the Power Plant Site

Table 10. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at the Power Plant Site

Sample Name	Oxygen Utilization Rate (%/hour)	Biodegradation Rate (mg/kg/day)	Carbon Dioxide Production Rate (%/hour)	Biodegradation Rate (mg/kg/day)
Background	0.11	2.2	0.079	1.7
G2-MPA-10.0′	0.32 7.68	6.2 6.13	0.087	1.9
G2-MPB-5.5′	0.95 22.8	18 18.21	0.18	3.9
G2-MPB-8.0′	2.2 52.8	42 42.17	0.37	8.0
G2-MPC-8.0′	2.2 52.8	42 42.17	0.33	7.1

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were measured during the in situ respiration test. Temperatures during the test ranged from 13.1°C to 14.0°C at monitoring point G2-MPA-4.0′ and from 10.7°C to 11.3°C at monitoring point G2-MPA-10.0′.

3.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at the Power Plant Site. The bioventing system will not be installed until spring 1993.

4.0 MILLION GALLON HILL SITE

4.1 Chronology of Events and Site Activities

Existing wells were used at the Million Gallon Hill Site to screen for free product and soil gas concentrations. Due to the depth to groundwater, conventional soil gas survey methods were not employed. An existing well was used as a vent well for the air permeability test. No soil samples were taken at this location.

4.1.1 Groundwater Measurements

Groundwater and free product measurements were taken in an existing well which was used as the vent well at the Million Gallon Hill Site. The depth to free product was recorded at 31.87 feet, the depth to water was 31.91 feet, and the depth to the bottom of the well was 43 feet.

4.1.2 Soil Gas Survey

On August 19, 1992, a soil gas survey was conducted with existing vent wells to measure soil gas concentrations at the Million Gallon Hill Site. Measurements of soil gas were taken as described in Section 2.1.2.

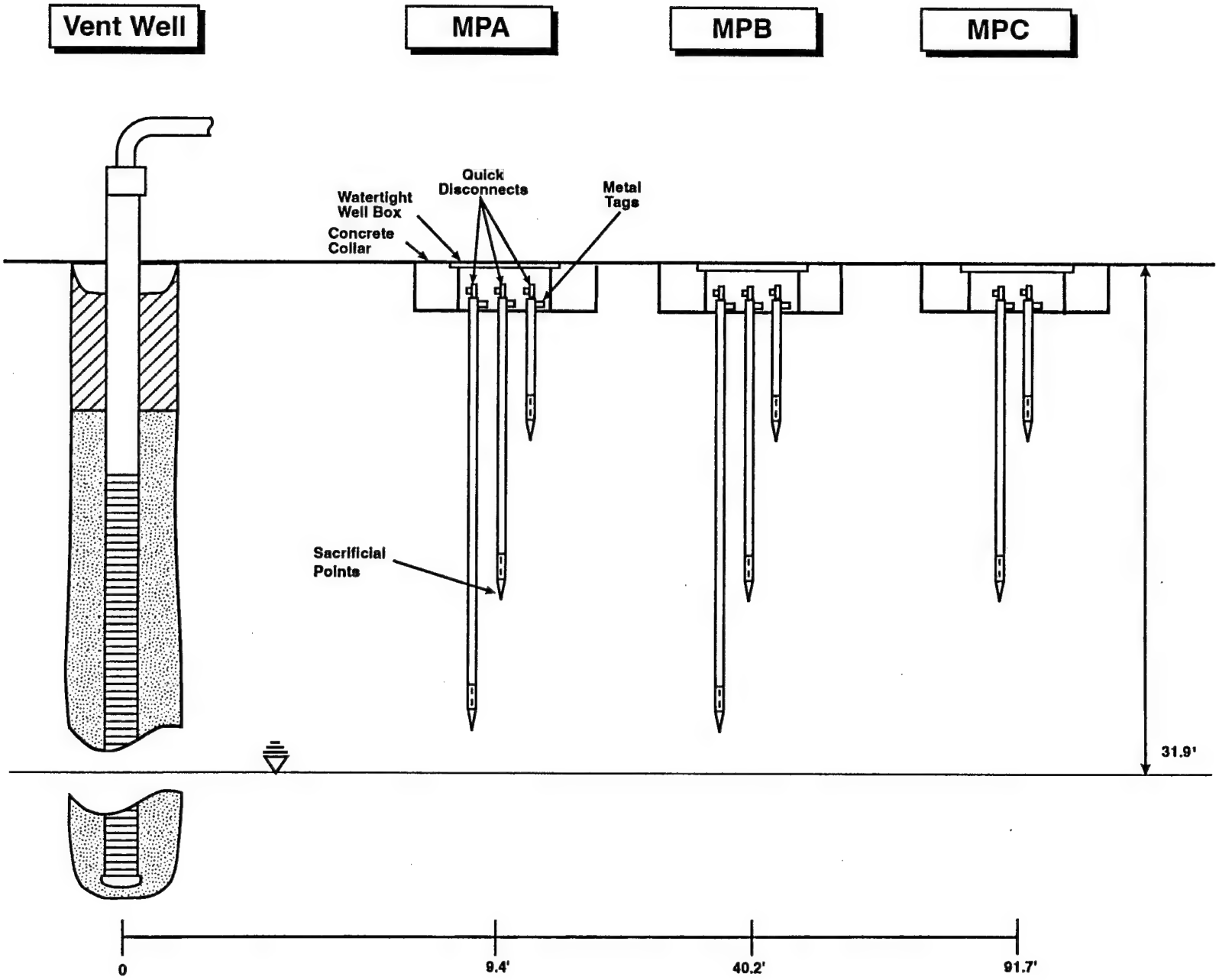
Oxygen concentrations were measured in the vent well and in several soil gas probes. Oxygen concentrations ranged from 0 to 17%, and TPH concentrations ranged from 60 to 71,200 ppm (Table 11). These measurements indicated that this area may be suitable for bioventing.

4.1.3 Vent Well, Monitoring Point, and Thermocouple Installation

On August 27, three monitoring points were installed. The monitoring points were labeled G3-MPA, G3-MPB, and G3-MPC. The locations of the vent well and monitoring points are shown in Figure 3. A cross section of a generic vent well and the monitoring points showing site lithology and construction detail is shown in Figure 12.

Table 11. Initial Soil Gas Composition at the Million Gallon Hill Site

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	10.0	17.0	2.9	60
	20.0	14.2	3.9	60
	27.5	0	5.5	600
GS-3	27.5	0	6.5	1,000
GS-4	20.0	16.0	2.5	4,400
Vent Well		8.1	8.5	71,200



F/Leeson/GA3

Figure 12. Cross Section of Vent Well and Monitoring Points at the Million Gallon Hill Site Showing Site Lithology and Construction Detail (not to scale)

Soil gas probes were sacrificial points which consisted of ¼-inch tubing with an aluminum, 4-inch screened area. No soil borings were created nor was any sand added. A small amount of wetted bentonite was added at the surface. The sacrificial points were driven into the soil using a hammer drill. The monitoring points were installed at depths as follows:

- Monitoring point G3-MPA was installed at a depth of 27.5 feet. The monitoring point was screened to three depths: 10.0, 20.0, and 27.5 feet.
- Monitoring point G3-MPB was installed at a depth of 27.5 feet. The monitoring point was screened to three depths: 10.0, 20.0, and 27.5 feet.
- Monitoring point G3-MPC was installed at a depth of 20 feet. The monitoring point was screened to two depths: 10.0 and 20.0 feet.

A Type J thermocouple was installed with monitoring points G3-MPA-10.0′ and G3-MPA-27.5′.

4.1.4 Soil Gas Sampling and Analyses

Soil gas samples were collected at the Million Gallon Hill Site from the vent well and from monitoring points G3-MPA and G3-MPB, and were labeled M vent well (Radian), M-MPA 27.5, and M-MPB 27.5. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

4.1.5 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute k, the soil gas permeability, is presented by the Test Plan and Technical Protocol (Hinchee et al., 1992).

The monitoring points at the Million Gallon Hill Site were allowed to set up for 96 hours prior to air injection. A portable 1-HP explosion-proof positive displacement blower unit was used to inject air. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The Hyperventilate™ computer model was used to calculate the soil gas permeability.

4.1.6 In Situ Respiration Test

Immediately following the soil gas permeability test at the Million Gallon Hill Site, air containing approximately 1% helium was injected into the soil for approximately 20 hours, beginning on September 1. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test was as described by the Test Plan and Technical Protocol (Hinchee et al., 1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through the following monitoring points: G3-MPA-20.0′; G3-MPA-27.5′; G3-MPB-20.0′; and G3-MPB-27.5′. The respiration gases were monitored periodically after the air/helium injection was turned off. The respiration test was terminated on September 4.

4.2 Results and Discussion

4.2.1 Soil Gas Analyses

Results of the soil gas analyses for BTEX and TPH at the Million Gallon Hill Site are presented in Table 12. The analytical report for this site is presented in Appendix B. The soil gas analyses showed relatively low BTEX and TPH concentrations, with concentrations ranging from 0.082 ppmv (benzene) to 13 ppmv (benzene) and from 26 to 3,600 ppmv of TPH.

4.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at Million Gallon Hill Site are presented in Appendix G. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data are presented in Table 13. The soil gas permeability was somewhat variable, with values ranging from less than 1.0×10^{-5} up to 590 darcy. The radius of influence where 1 inch of water could be measured was calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the vent well (Figure 13). The radius of influence at the Million Gallon Hill Site is approximately 33 feet.

Table 12. Results From Soil Gas Analyses for BTEX and TPH at the Million Gallon Hill Site

Matrix	Sample Name	Benzene (ppmv)	Toluene (ppmv)	Ethylbenzene (ppmv)	Total Xylenes (ppmv)	TPH[1] (ppmv)
Soil Gas	M vent well (Radian)	0.082	0.30	0.16	0.035	26
	M-MPA 27.5	6.0	5.8	3.8	0.94	3,600
	M-MPB 27.5	13	11	3.6	0.94	2,300

[1] TPH referenced to gasoline (molecular weight = 100).

Table 13. Results of Hyperventilate™ Soil Gas Permeability Analysis at the Million Gallon Hill Site

Monitoring Point	Depth (ft)	Soil Gas Permeability (darcy)
G3-MPA	10.0	590
	20.0	6.1
	27.5	240
G3-MPB	10.0	20
	20.0	27
	27.5	28
G3-MPC	10.0	$< 1.0 \times 10^{-5}$
	20.0	$< 1.0 \times 10^{-5}$

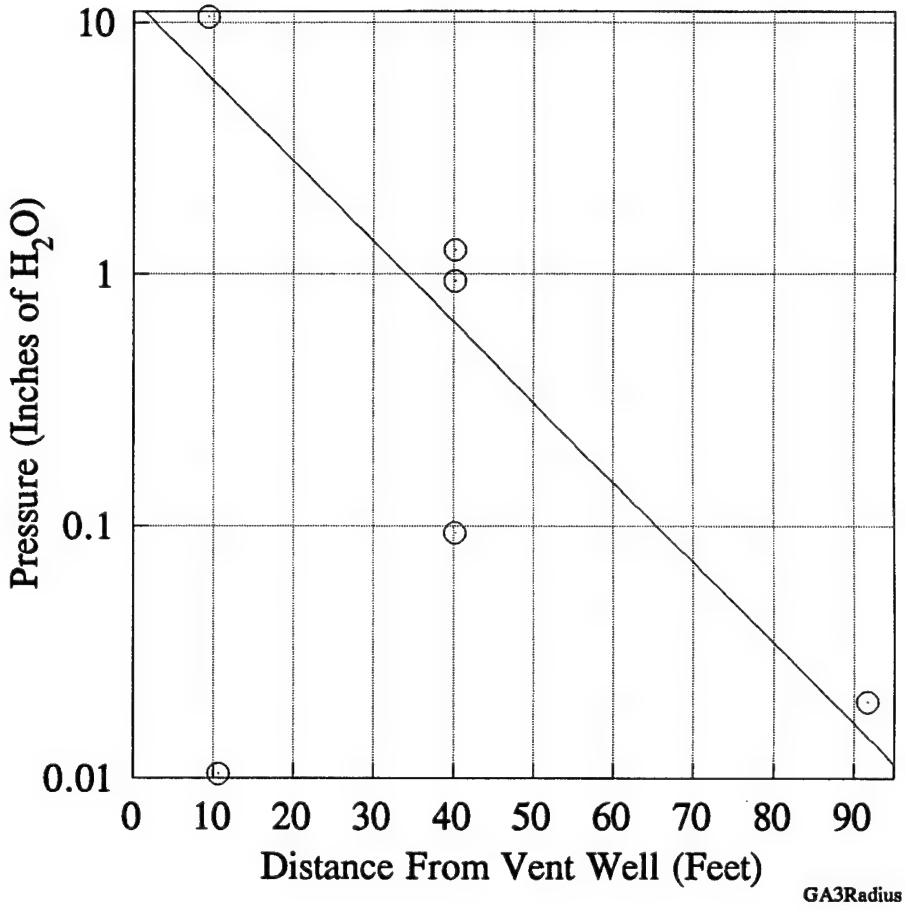


Figure 13. Radius of Influence at the Million Gallon Hill Site

4.2.3 In Situ Respiration Test

The results of the in situ respiration test for the Million Gallon Hill Site are presented in Appendix H. Each figure in Appendix H illustrates the oxygen and helium concentrations as a function of time. An example of typical oxygen utilization at this site is shown in Figure 14, where oxygen and helium at monitoring point G3-MPA-27.5′ are illustrated. A summary of the oxygen utilization rates and corresponding biodegradation rates is shown in Table 14. The biodegradation rates measured at this site were fairly consistent between the monitoring points, with rates ranging from 4.5 to 11 mg/kg/day for oxygen utilization, and 1.0 to 2.6 mg/kg/day for carbon dioxide production.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were not monitored at this site during the in situ respiration test.

4.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at Million Gallon Hill Site. The bioventing system will not be installed until spring 1993.

Table 14. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at the Million Gallon Hill Site

Sample Name	Oxygen Utilization Rate (%/hour)	Biodegradation Rate (mg/kg/day)	Carbon Dioxide Production (%/hour)	Biodegradation Rate (mg/kg/day)
Background	0.11	2.2	0.079	1.7
G3-MPA-20.0′	0.24 5.76	4.5 4.60	0.12	2.6
G3-MPA-27.5′	O.51 12.24	9.7 9.79	0.048	1.0
G3-MPB-20.0′	0.42 10.08	8.0 8.05	0.091	2.0
G3-MPB-27.5′	0.57 13.68	11 10.92	0.094	2.0

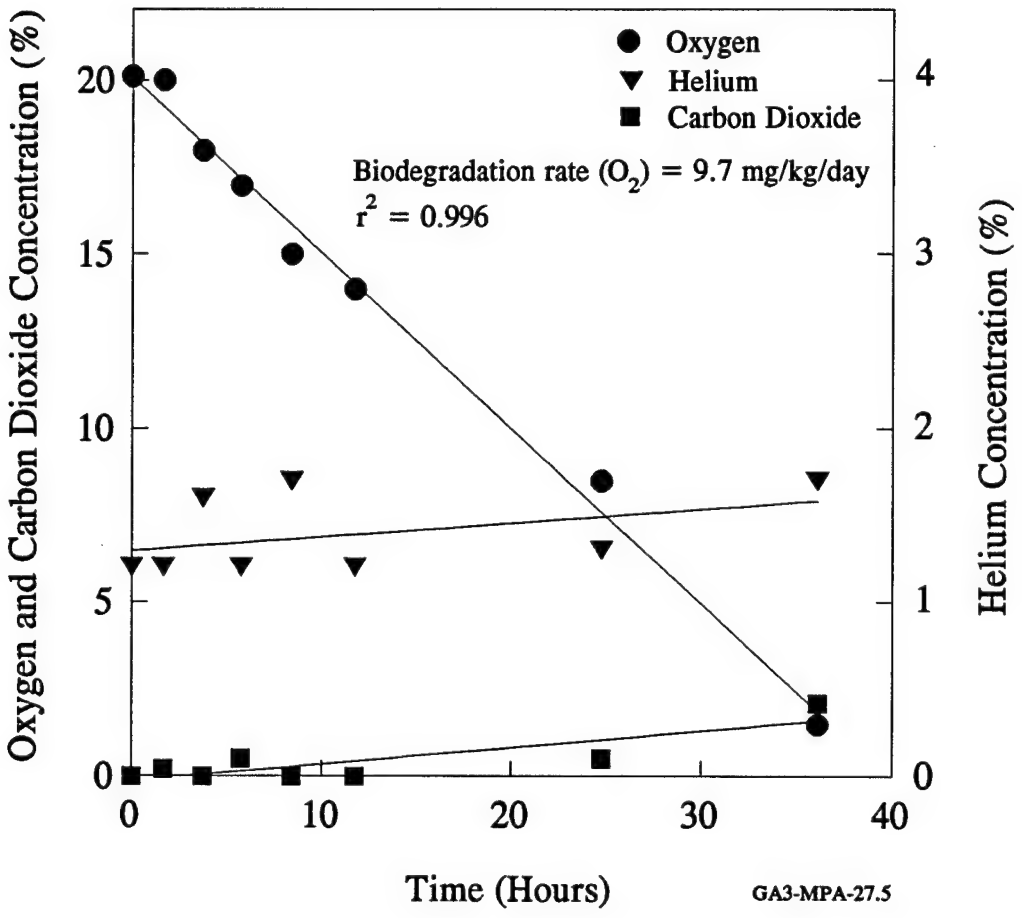


Figure 14. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G3-MPA-27.5′ at the Million Gallon Hill Site

5.0 CAMPION POL TANK SITE

5.1 Chronology of Events and Site Activities

5.1.1 Groundwater Measurements

Groundwater levels were measured at 7.9 feet in the vent well described in Section 5.1.3.

5.1.2 Soil Gas Survey

A limited soil gas survey was conducted on August 18, 1992 to locate a suitable test area at the Campion POL Tank Site. Soil gases were sampled by driving a ⅝-inch diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH. Soil gas measurements were taken as described in Section 2.1.2.

The soil gas probes were driven to depths ranging from 2.5 to 7.5 feet at several locations at the Campion POL Tank Site. Once groundwater were encountered, the probes were not driven deeper. Table 15 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at the Campion POL Tank Site. Relatively low oxygen concentrations were found at most of the soil gas probes, whereas relatively high concentrations of carbon dioxide and TPH were encountered. These concentrations indicate that this area may respond to bioventing.

5.1.3 Vent Well, Monitoring Point, and Thermocouple Installation

On August 19 the vent well and three monitoring points were installed at the Campion POL Tank Site, and soil samples were collected for analyses. The monitoring points were labeled C1-MPA, C1-MPB, and C1-MPC. The locations of the vent well and monitoring points are shown in Figure 4. A cross section of the vent well and monitoring points showing site lithology and construction detail is shown in Figure 15.

The vent well was installed at a depth of 9.0 feet into a 6-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter PVC piping with 4.5 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, whereas the

Table 15. Initial Soil Gas Composition at the Campion POL Tank Site

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	2.5	20.9	0.05	20
	5.0	15.0	4.8	2,000
GS-2	2.5	0.5	10.0	7,800
GS-3	2.5	1.0	9.9	1,040
GS-4	2.5	0	11.0	1,280
	5.0	0.1	11.0	1,680
	7.5	6.0	9.0	760
GS-5	2.5	2.0	9.0	2,400
	5.0	2.0	9.1	3,200
GS-6	2.5	3.8	6.5	640
GS-7	5.0	1.0	10.0	2,800

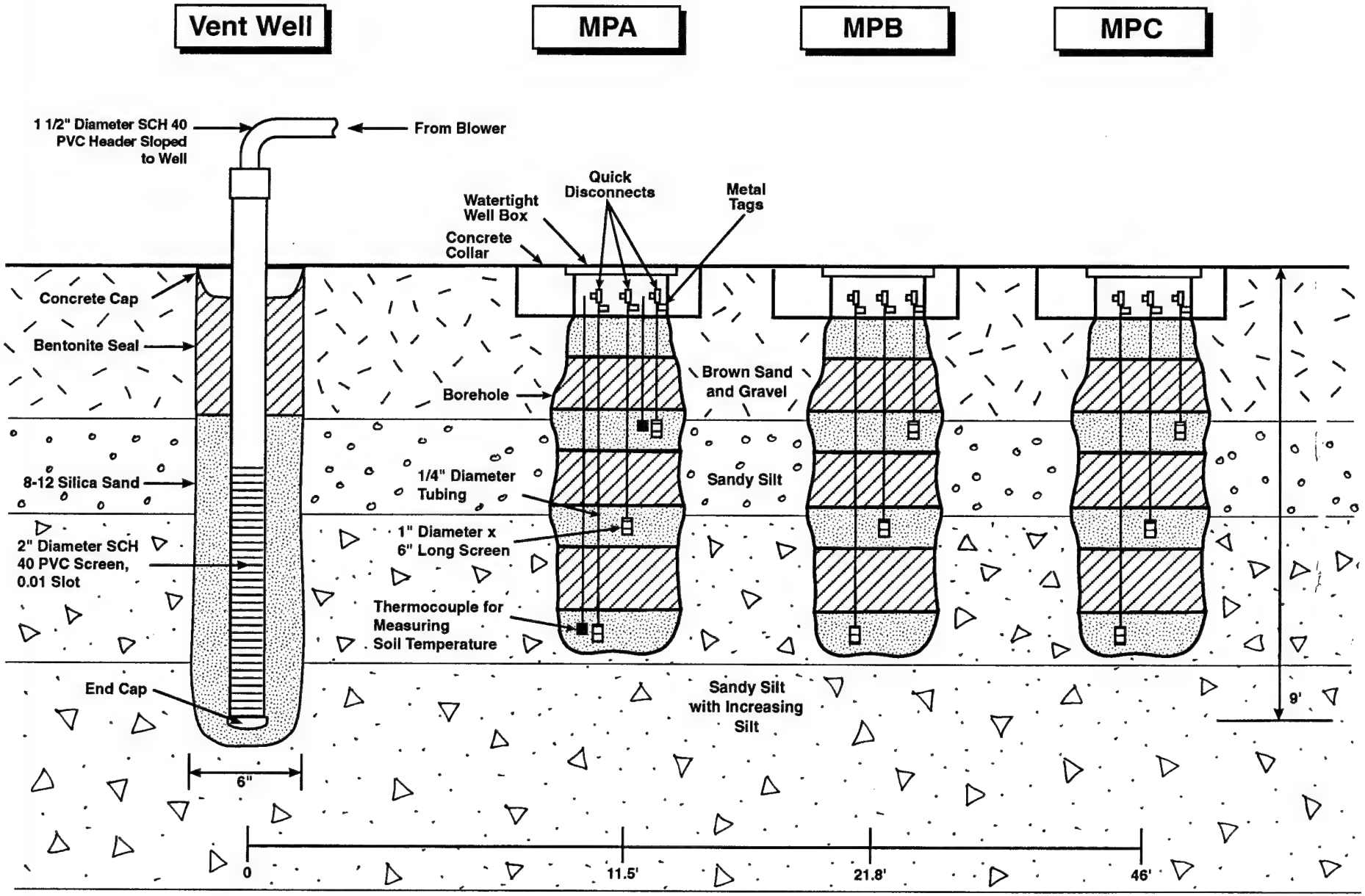


Figure 15. Cross Section of Vent Well and Monitoring Points at the Campion POL Tank Site Showing Site Lithology and Construction Detail (not to scale)

F/Leeson/CA1

annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil gas probes consisted of ¼-inch tubing connected to a 1-inch-diameter, 6-inch screened area. The annular space corresponding to the screened area was filled with silica sand, whereas the interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. The monitoring points were installed at a depth of 7.3 feet into an 8-inch-diameter borehole and screened to three depths: 3.0, 5.0, and 7.0 feet.

A Type J thermocouple was installed with monitoring points C1-MPA-3.0′ and C1-MPA-7.0′.

5.1.4 Soil and Soil Gas Sampling and Analyses

Soil samples were collected at depths of 4.0 to 4.5 feet, 6.0 to 6.5 feet, and 9.0 to 9.5 feet from the vent well borehole and were labeled CA-V-4.0, CA-V-6.0, and CA-V-9.0, respectively. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analysis of BTEX, TPH, alkalinity, moisture content, pH, iron, total phosphorous, and total Kjeldahl nitrogen.

Soil gas samples were collected from the vent well and monitoring points C1-MPA and C1-MPC and were labeled vent well, MPA red, and monitor point C blue. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH.

5.1.5 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute k, the soil gas permeability, is presented by the Test Plan and Technical Protocol (Hinchee et al., 1992).

The monitoring points were left in place for 96 hours prior to air injection. Air was injected with a portable 1-HP explosion-proof positive displacement blower unit. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The Hyperventilate™ computer model was used to calculate the soil gas permeability.

5.1.6 In Situ Respiration Test

Immediately following the soil gas permeability test, air containing approximately 1% helium was injected into the soil for approximately 20 hours beginning on August 28. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The in situ respiration test was set up as described in the Test Plan and Technical Protocol (Hinchee et al., 1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through monitoring points C1-MPA-7.0′, C1-MPB-5.0′, C1-MPB-7.0′, and C1-MPC-5.0′. The respiration gases were monitored periodically after the air/helium injection was turned off. The respiration test was terminated on August 31.

5.2 Results and Discussion

5.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH are presented in Table 16. The analytical report for this data is presented in Appendix B. Relatively low concentrations of BTEX and TPH were found in soil samples, with concentrations ranging from below detection limits (all BTEX compounds) up to 0.74 mg/kg (toluene) and from 180 to 1,700 mg/kg of TPH. The soil gas analyses also showed relatively low BTEX and TPH concentrations, with concentrations ranging from less than 0.002 ppmv (benzene) up to 0.39 ppmv (total xylenes) and from 10 to 750 ppmv of TPH (Table 16). The results from the soil chemistry analyses are summarized in Table 17.

5.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at the Campion POL Tank Site are presented in Appendix I. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data are presented in Table 18. The soil gas permeability varied considerably, with values ranging from less than 1.0×10^{-5} up to greater than 1.0×10^{10} darcy. The radius of influence where 1 inch of water could be measured was calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the vent well (Figure 16). The radius of influence at the Campion POL Tank Site is approximately 5 feet.

Table 16. Results From Soil and Soil Gas Analyses for BTEX and TPH at the Campion POL Tank Site

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH[1] (mg/kg)
Soil	CA-V-4.0	<0.0034	<0.0039	<0.0028	<0.09	180
	CA-V-6.0	<0.0032	0.74	<0.0026	0.47	1,700
	CA-V-9.0	0.085	<0.0017	<0.0012	0.092	390
Matrix	**Sample Name**	**Benzene (ppmv)**	**Toluene (ppmv)**	**Ethylbenzene (ppmv)**	**Total Xylenes (ppmv)**	**TPH[2] (ppmv)**
Soil Gas	Vent well	0.05	0.069	0.15	0.39	750
	MPA red	0.014	0.033	0.006	0.22	1.4
	Monitor point C blue	<0.002	0.019	0.005	0.052	10

[1] Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

[2] TPH referenced to gasoline (molecular weight = 100).

Table 17. Results From Soil Chemistry Analyses at the Campion POL Tank Site

Parameter	Sample Name		
	CA-V-4.0	CA-V-6.0	CA-V-9.0
Alkalinity (mg/kg $CaCO_3$)	230	190	490
Moisture (% by weight)	11.2	5.9	19.7
pH	8.3	8.3	7.6
Iron (mg/kg)	15,800	11,000	18,700
Total Phosphorus (mg/kg)	510	510	690
Total Kjeldahl Nitrogen (mg/kg)	510	430	1,200

Table 18. Results of Hyperventilate™ Soil Gas Permeability Analysis at the Campion POL Tank Site

Monitoring Point	Depth (ft)	Soil Gas Permeability (darcy)
C1-MPA	3.0	$< 1.0 \times 10^{-5}$
	5.0	$< 1.0 \times 10^{-5}$
	7.0	$< 1.0 \times 10^{-5}$
C1-MPB	3.0	$< 1.0 \times 10^{-5}$
	5.0	$< 1.0 \times 10^{-5}$
	7.0	1.2
C1-MPC	3.0	2.1×10^{9}
	5.0	$> 1.0 \times 10^{10}$
	7.0	$> 1.0 \times 10^{10}$

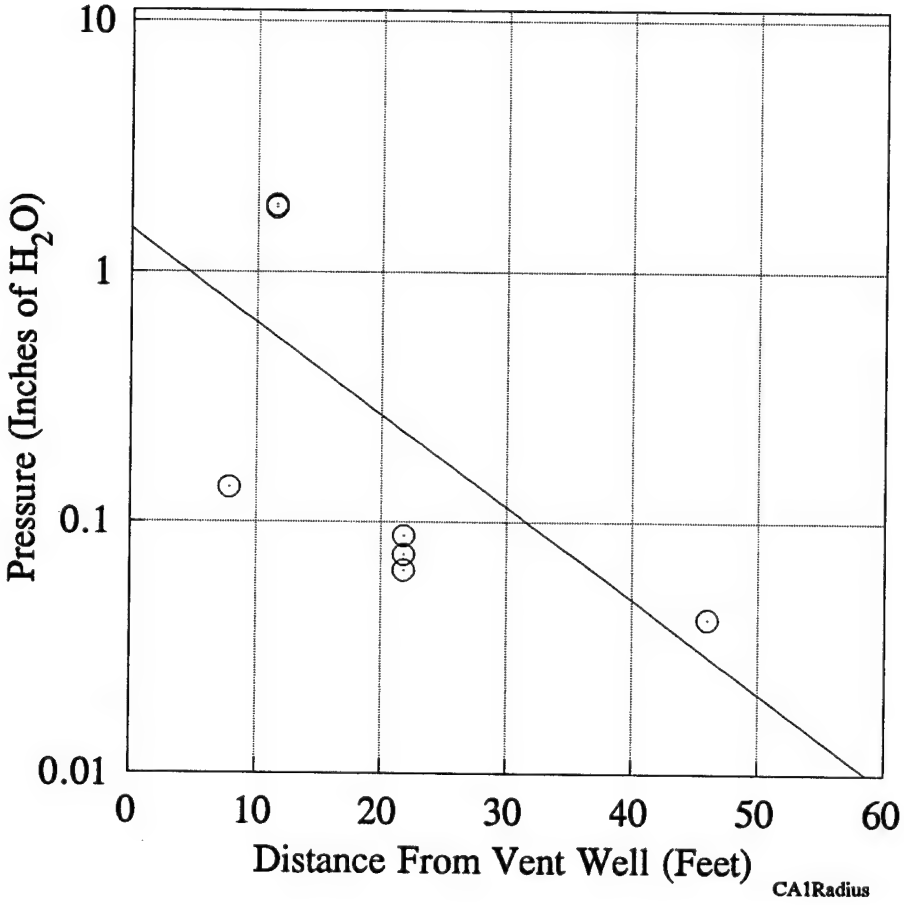


Figure 16. Radius of Influence at the Campion POL Tank Site

5.2.3 In Situ Respiration Test

The results of the in situ respiration test for the Campion POL Tank Site are presented in Appendix J. Each figure in Appendix J illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization at this site is shown in Figure 17, which illustrates oxygen utilization and carbon dioxide production at monitoring point C1-MPC-5.0′. The oxygen utilization and carbon dioxide production rates and corresponding biodegradation rates are summarized in Table 19. The biodegradation rates measured at this site were quite high, with rates ranging from 6.4 to 29.0 mg/kg/day for oxygen utilization, and from 2.6 to 6.0 mg/kg/day for carbon dioxide production.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were measured during the in situ respiration test. Temperatures during the test ranged from 9.3°C to 9.8°C at monitoring point C1-MPA-3.0′ and from 4.2°C to 5.4°C at monitoring point C1-MPA-7.0′.

5.2.4 Bioventing Demonstration

Although high biodegradation rates indicated that this site would be a good candidate for bioventing, a system could not be installed due to the unavailability of a power source.

Table 19. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at the Campion POL Tank Site

Sample Name	Oxygen Utilization Rate (%/hour)	Biodegradation Rate (mg/kg/day)	Carbon Dioxide Production Rate (%/hour)	Biodegradation Rate (mg/kg/day)
Background	0.11	2.2	0.079	1.7
C1-MPA-7.0′	1.5	29	0.28	6.0
C1-MPB-5.0′	0.74	14	0.14	3.1
C1-MPB-7.0′	1.4	27	0.15	3.2
C1-MPC-5.0′	0.33	6.4	0.12	2.6

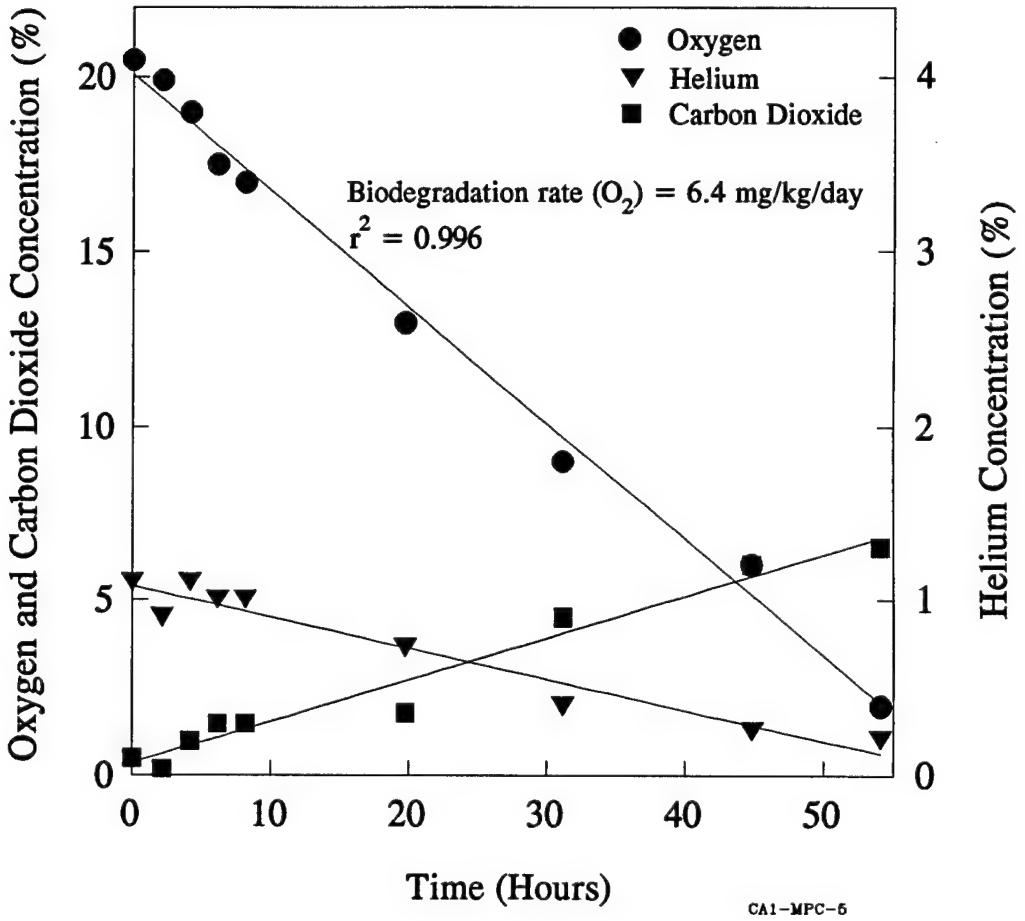


Figure 17. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point C1-MPC-5.0′ at the Campion POL Tank Site

6.0 BACKGROUND AREA

The background vent well and monitoring points were located upgradient from the contaminated site at Campion AFS, approximately 200 feet away. The vent well was installed at a depth of 8.5 feet. The vent well consisted of Schedule 40 2-inch-diameter PVC piping with 5.0 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, whereas the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface. The site lithology at this area was representative of that in the contaminated areas.

An in situ respiration test was conducted at the background area beginning on August 28, 1992 after 24 hours of air injection. The test was concluded on August 31. The biodegradation rate was relatively high at this area, considering that it is a background, uncontaminated location (Figure 18).

7.0 FUTURE WORK

The bioventing systems at Galena AFS will be installed in spring 1993. Once the system is operating, base personnel will be required to perform a simple weekly system check to ensure that the blower is operating within its intended flowrate, pressure, and temperature range. An on-site briefing for base personnel who will be responsible for blower system checks will be conducted when the blowers are installed. The principle of operation will be explained, and a simple checklist and logbook will be provided for blower data. Base personnel will be asked to perform minor maintenance activities, such as replacing filters or gauges, or draining condensate from knockout chambers, but they will not be expected to perform complicated repairs or analyze gas samples. Replacement filters and gauges will be provided and shipped to the base, and serious problems, such as motor or blower failures, will be corrected by Battelle.

The progress of this system will be monitored by conducting semiannual respiration tests in the vent well and in each monitoring point and by regularly measuring the oxygen, carbon dioxide, and hydrocarbon concentrations in the extracted soil gas and comparing them to background levels. At least twice each year, the progress of the bioventing test will be reported to the base POC.

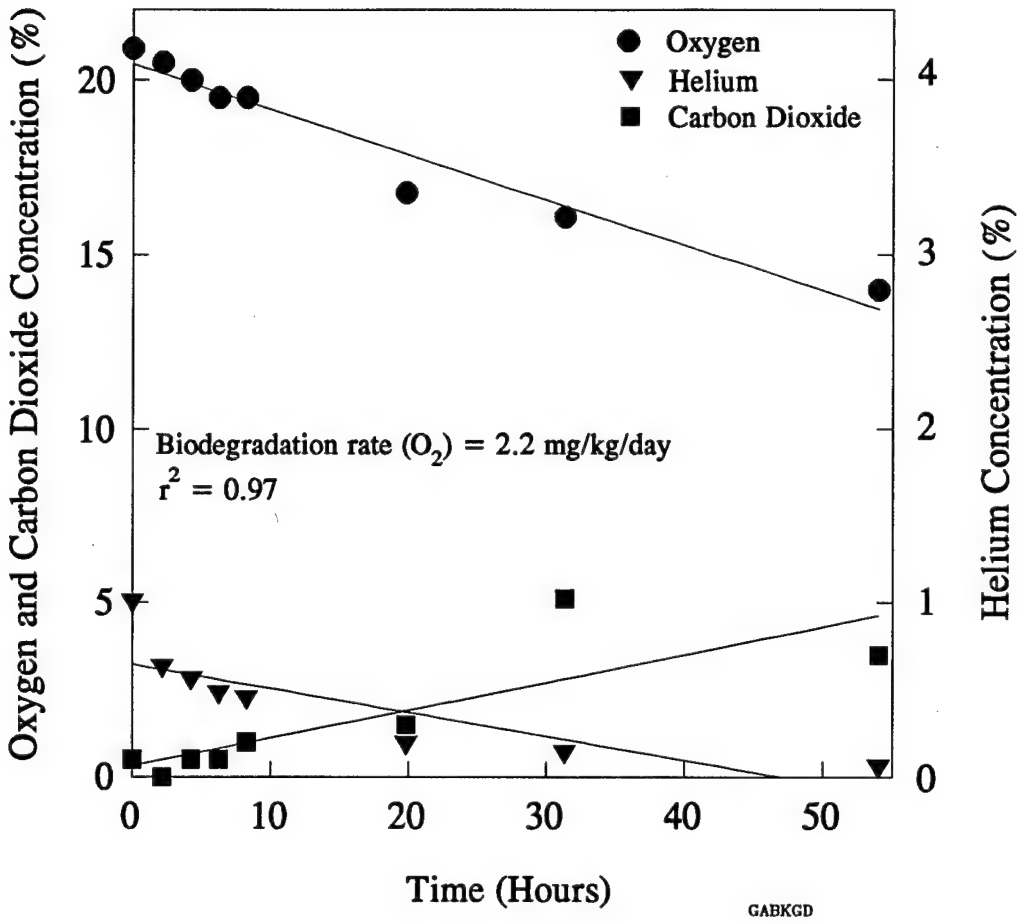


Figure 18. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at the Background Area

8.0 REFERENCE

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Rev. 2), Report prepared by Battelle Columbus Operations, U.S. Air Force Center for Environmental Excellence, and Engineering Sciences, Inc. for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

APPENDIX A

TEST PLAN FOR GALENA AND CAMPION AFS, ALASKA

Battelle
. . . Putting Technology To Work

505 King Avenue
Columbus, Ohio 43201-2693
Telephone (614) 424-6424
Facsimile (614) 424-5263

August 5, 1992

Capt. Catherine Vogel
HQ AFCESA/RAVW
139 Barnes Drive
Tyndall Air Force Base,
Florida 32403-5319

Dear Cathy:

SUBJECT: TEST PLAN FOR BIOVENTING INITIATIVE FIELD TEST AT GALENA AFS AND CAMPION AFS, AK

This letter was prepared to accompany the report "Test Plan and Technical Protocol for a Field Treatability Test for Bioventing." The protocol document was developed as a generic test plan for the Air Force Bioventing Initiative Project in which Galena AFS is participating. This letter outlines site specific information to support the generic test plan.

The sites anticipated for the bioventing test initiative are Tanks 37 and 38, Tank 49 (base power plant), and the Saddle Tank farm area at Galena AFS, and POL leak site 1 (former location of the Campion fuel tank farm) at Campion AFS. The selection of these sites was based on observations I made during my site visit to Galena/Campion AFS and with the concurrence of base POC 1st Lieutenant Kevin Swisher.

The purpose of this project is to investigate the feasibility of using the bioventing technology to remediate petroleum contaminated soils at the above mentioned facilities.

Site Descriptions-

Galena AFS is located approximately 280 miles west of Fairbanks, AK on the Yukon river. The installation is a forward operating base of the U.S. Air Force Alaska Air Command. Approximately 350 military personnel are currently assigned to the base and the population of the adjacent community of Galena is approximately 750. Galena is not connected by road to any other community and is only accessible by air or water.

Campion AFS, located approximately 12 miles east of Galena, was deactivated and demolished in the early to mid- 1980's. The site is accessible by gravel road from Galena AFS. There are no buildings and electrical power is currently not accessible from the site.

Tanks 37 and 38 (Galena)- Tank 37 and tank 38 are large capacity above ground petroleum storage tanks containing diesel and JP-4, respectively (see figure 1). The tanks are located in a fuel storage tank farm along with JP-4 storage tanks 41 and 42. The tank farm is located on a fill mound built up approximately 30 ft above grade. Groundwater is located at approximately 40 ft below the tanks and soil analytical data indicates that contamination is primarily encountered at depths greater than 20 ft. Table 1 summarizes the available analytical data for Tanks 37 and 38.

Saddle Tank Farm (Galena)- The saddle tank farm area is located east of Tanks 37 and 38. The tank farm contains approximately 20 above ground petroleum storage tanks in a diked area. Groundwater at the site is typically encountered at less than 10 ft. The base POC located an area just east of the containment dike that is believed to be a good candidate site for the bioventing demonstration. This site is located several hundred feet from a vapor extraction pilot study being conducted by Radian Corporation. Soil analytical data has not been made available for this site.

Diesel Tank 49 (Galena)- Tank 49 is a 20,000 gallon diesel tank located adjacent to the base power plant (see figure 1). Groundwater is encountered at approximately 10 ft at the site. Soil analytical data has indicated TPH concentrations in excess of 10,000 ppm (see Table 2).

POL Leak Site 1 (Campion)- POL Leak Site 1 is located in the former petroleum storage tank farm at Campion AFS. The tanks have been removed, but their former location is evidenced by circular gravel pads inside a diked area. Soil samples from the site have indicated TPH concentrations of 300 to 500 ppm. Groundwater at the site is present at approximately 10 ft.

Project activities-

The following field activities are planned for the bioventing project at Galena/Campion AFS. The same procedures will be followed at each site (except Tanks 37 and 38). Additional detail can be found in Section 5.0 of the generic test plan and technical protocol.

1- A small scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system. Soil vapor from the candidate site must exhibit high petroleum hydrocarbon concentrations (10,000 ppm or greater), relatively low O_2 concentrations (0 % to 2.0 %), and relatively high CO_2 concentrations (depending on soil type, 2.0 % to 10.0 %). An uncontaminated background location will also be identified.

2- Once the installation sites are located one vent well and three 3-level soil gas monitoring points will be installed in the contaminated location and one vent well will be installed in the background area. The wells and monitoring points will be installed using a two-man power auger to bore down to just above the water table.

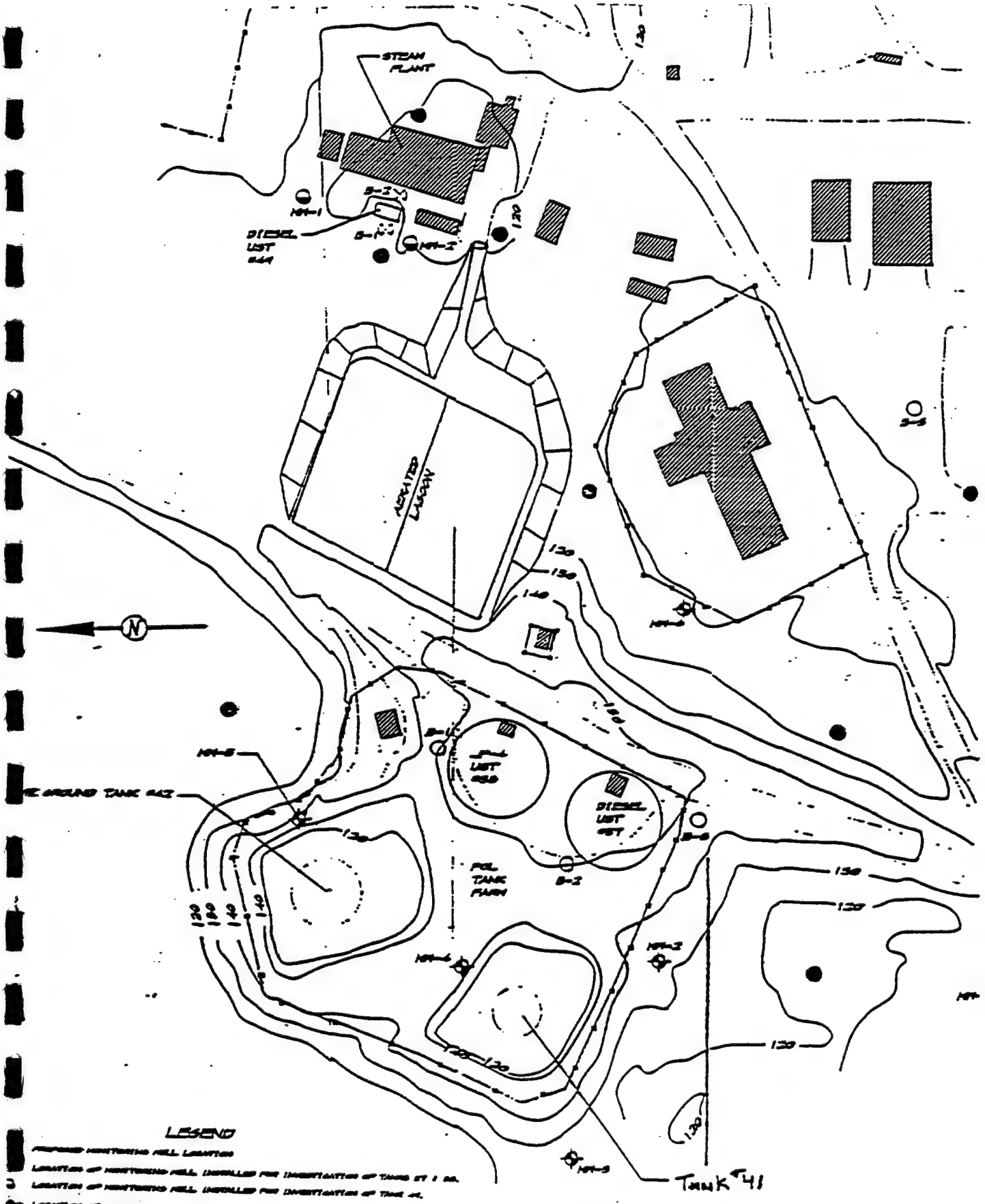


FIGURE 1. SITE MAP FOR TANKS 37 & 38, AND TANK 49, GALENA AFS, ALASKA.

TABLE 1. CONTAMINANT CONCENTRATIONS AT TANKS 37 AND 38, GALENA AFS, AK.

SAMPLE LOCATION	DEPTH(ft)	CONCENTRATION (mg/Kg) TPH	BENZENE	TOLUENE	ETHYLBENZENI	XYLENE
MW-2	20	6460	0.336	1.4	1.4	4.23
MW-3	10	<11.5	<.021	<.02	<.02	<.063
MW-4	14.5	28.3	<.018	<.02	<.02	<.055
MW-5	20.5	<11.2	<.02	<.02	<.02	<.059
MW-5	29.5	327	14.3	71	32	126
B-1	19	40.6	0.024	0.05	<.02	<.06
B-1	29	169	0.293	3.6	1.5	6.94
B-1	39	7720	3.19	40	13	93.7
B-1	44	7650	4.55	49	17	85.3
B-2	14	26.8	<.02	<.02	<.02	<.061
B-2	24	322	0.027	<.01	0.08	0.3
B-2	34	3060	0.488	3	3.9	15.6
B-2	44	18200	1.93	11	9.5	34.2
B-3	5	1140	<.042	<.04	<.04	<.127
B-3	19	17.9	0.14	1.8	3.2	19.8
B-3	29	5810	0.061	1.6	2.3	12.6
B-3	39	1670	0.526	8.1	14	87.6

TABLE 2. CONTAMINANT CONCENTRATIONS AT TANK 49, GALENA AFS, AK.

SAMPLE LOCATION	DEPTH(ft)	CONCENTRATION (mg/Kg) TPH	BENZENE	TOLUENE	ETHYLBENZENE	XYLENE
B–1	5	7630	<.019	0.16	<.02	5.72
B–1	10	12500	<.184	4.7	23	110
B–2	1	2360	0.74	12	37	356
B–2	9	6380	<.061	0.47	<.06	20.5
MW–2	1	13100	0.239	5.9	9.9	66.7
MW–2	9.5	1270	<.019	0.08	<.02	3.51

Three to four soil samples will be collected for chemical/physical analysis.

3- The air permeability test will be conducted in the contaminated test location.

4- Following the air permeability test, in situ respiration tests will be conducted in both the contaminated and the background test locations.

5- Depending on the results of the air permeability test and the in situ respiration test, a decision will be made whether or not to install a blower system in the contaminated area for the long term bioventing test. If the decision is made to install, the blower will be plumbed to the vent well and bioventing will be started (assuming power is available). Site personnel will be trained for blower operation prior to Battelle leaving the site.

Procedures for Tanks 37 and 38-

The same basic procedures will be followed at the Tanks 37 and 38 site, with the following exceptions:

1- Existing site wells will be screened for free product and soil vapor concentrations. Due to the depth to groundwater, conventional soil gas survey methods will not be employed.

2- A existing well will be selected for use as a vent well.

3- Sacrificial soil vapor probes will be driven to the maximum depth possible with a 20 lb impact drill. These points, along with other existing wells, will be used for soil gas and pressure monitoring points.

Schedule-

Field activities at Galena/Campion are planned to begin on August 17, 1992. Battelle will have 2 to 3 people on site for approximately 3 weeks.

Base Support-

Galena AFS needs to be able to provide the following:

- Digging permits and utility clearance for all sites need to be obtained prior to the

initiation of the field work. Underground utilities should be clearly marked to reduce the chance of utility damage or personal injury during soil gas probe and well installation. Battelle will not be able to begin field operations without these clearances.

- Electrical power will need to be easily accessible from the project site. The air permeability test and in situ respiration test can be performed using a gasoline powered electric generator. The operation of the bioventing system will require a permanent 220/110 V power source. If power will not be available immediately after the test is completed the bioventing system will be installed for start-up at a later date. Due to the remote location of the Campion sites no blower will be installed during the initial field effort. If the Air Force determines that installation is desirable at a later date (after power requirements for the blower can be met) Battelle will install the blower during a scheduled Galena AFS site visit.

- Regulatory approval, if any is required, will need to be obtained by the base prior to start-up of the bioventing system. The system will likely be configured for air injection so there will be no point source vapor emission from the system. The wells to be installed will not intersect the apparent water table and no groundwater will be pumped. Ms. Laura Noland of the Alaska Department of Environmental Conservation has indicated that their will be no problem installing and operating the bioventing system (configured for injection), pending her review of this site specific test plan.

- Drums for containment of contaminated soil cuttings. The base will be responsible for disposal of any contaminated soils.

- Base and site clearance will be required for Battelle's site employees. We will furnish the base POC with personal information for each person at least one week prior to starting field operations.

Thank you for your support for this bioremediation research project. If you have any questions please feel free to call me at (614) 424-6122.

Sincerely,

Jeffrey A. Kittel
Researcher
Environmental Technology Department

JAK:sh
Enclosure

APPENDIX B

ANALYTICAL REPORT FOR THE SADDLE TANK FARM SITE, THE POWER PLANT SITE, THE MILLION GALLON HILL SITE, AND THE CAMPION POL TANK SITE

@ AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9209042

Work Order Summary

CLIENT:	Mr. Jeff Kittle Battelle 505 King Ave. Columbus, OH 43201	**BILL TO:**	Accounts Payable Engineering Science 1700 Broadway Ste. 900 Denver, CO 80290
PHONE:	614-424-6122		**INVOICE #** 8461
FAX:	614-424-3667		**P.O. #** DE 268.03
DATE RECEIVED:	9/9/92		**AMOUNT:** $1,655.97
DATE REPORTED:	9/17/92		**PROJECT #**

FRACTION #	NAME	TEST	Receipt VAC./Press.	PRICE
01A	Vent Well	TO-3	1.5 "Hg	$120.00
02A	Power Plant MPC Red	TO-3	1.5 "Hg	$120.00
03A	MPC Red	TO-3	3.5 "Hg	$120.00
04A	M-MPB 27.5	TO-3	15.5 "Hg	$120.00
05A	M-MPA 27.5	TO-3	1.5 "Hg	$120.00
06A	M Vent Well (Radian)	TO-3	2.0 "Hg	$120.00
07A	Vent Well	TO-3	2.0 "Hg	$120.00
08A	Power Plant Vent Well	TO-3	1.5 "Hg	$120.00
09A	Monitor Point C blue	TO-3	0.5 "Hg	$120.00
10A	Power Plant MPA Red	TO-3	3.5 "Hg	$120.00
11A	MPA Red, Little or No Vacuum Flow	TO-3	0.2 psi	$120.00
12A	MPA Red	TO-3	1.0 "Hg	$120.00
12B	MPA Red Duplicate	TO-3	1.0 "Hg	NC
13A	Method Spike	TO-3	NA	NC
14A	Lab Blank	TO-3	NA	NC
14B	Lab Blank	TO-3	NA	NC

Misc. Charges	1 Liter SUMMA Canister Preparation (12) @ $10.00 each.	$120.00
	Shipping (8/21/92)	$95.97

REVIEWED BY: Craig Pearson DATE: 9/18/92

CERTIFIED BY: Jacqueline S. Pearson DATE: 9/18/92

AIR TOXICS LTD.

SAMPLE NAME: Vent Well
ID#: 9209042-01A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091007		Date of Collection: 9/1/92	
Dil. Factor:	21		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.021	0.066	0.050	0.16
Toluene	0.021	0.077	0.069	0.25
Total Xylenes	0.021	0.089	0.39	1.7
Ethyl Benzene	0.021	0.089	0.15	0.64

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	6091007		Date of Collection: 9/1/92	
Dil. Factor:	21		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.21	0.84	750	3000

*TPH referenced to Jet Fuel (MW=156)

AIR TOXICS LTD.

SAMPLE NAME: Power Plant MPC Red
ID#: 9209042-02A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091008	Date of Collection: 9/1/92	
Dil. Factor:	110	Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.11	0.34	Not Detected	Not Detected
Toluene	0.11	0.40	2.0	7.4
Total Xylenes	0.11	0.47	9.1	39
Ethyl Benzene	0.11	0.47	2.0	8.5

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	6091008	Date of Collection: 9/1/92	
Dil. Factor:	110	Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	1.1	4.4	1400	5600

*TPH referenced to Jet Fuel (MW=156)

AIR TOXICS LTD.

SAMPLE NAME: MPC Red
ID#: 9209042-03A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091009		Date of Collection:	9/1/92
Dil. Factor:	110		Date of Analysis:	9/10/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.11	0.34	Not Detected	Not Detected
Toluene	0.11	0.40	2.9	11
Total Xylenes	0.11	0.47	0.97	4.1
Ethyl Benzene	0.11	0.47	1.3	5.5

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	6091009		Date of Collection:	9/1/92
Dil. Factor:	110		Date of Analysis:	9/10/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	1.1	4.4	1500	6000

*TPH referenced to Jet Fuel (MW=156)

AIR TOXICS LTD.

SAMPLE NAME: M-MPB 27.5
ID#: 9209042-04A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091011		Date of Collection: 9/4/92	
Dil. Factor:	210		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.21	0.66	13	41
Toluene	0.21	0.77	11	40
Total Xylenes	0.21	0.89	3.6	15
Ethyl Benzene	0.21	0.89	0.94	4.0

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	6091011		Date of Collection: 9/4/92	
Dil. Factor:	210		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	2.1	8.4	2300	9200

*TPH referenced to Jet Fuel (MW=156)

AIR TOXICS LTD.

SAMPLE NAME: M-MPA 27.5
ID#: 9209042-05A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091012		Date of Collection: NP	
Dil. Factor:	530		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.53	1.7	6.0	19
Toluene	0.53	2.0	5.8	21
Total Xylenes	0.53	2.2	3.8	16
Ethyl Benzene	0.53	2.2	0.94	4.0

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	6091012		Date of Collection: NP	
Dil. Factor:	530		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	5.3	21	3600	14000

*TPH referenced to Jet Fuel (MW=156)

AIR TOXICS LTD.

SAMPLE NAME: M Vent Well (Radian)
ID#: 9209042-06A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091014		Date of Collection: 9/4/92	
Dil. Factor:	2.2		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.007	0.082	0.26
Toluene	0.002	0.008	0.30	1.1
Total Xylenes	0.002	0.009	0.16	0.68
Ethyl Benzene	0.002	0.009	0.035	0.15

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	6091014		Date of Collection: 9/4/92	
Dil. Factor:	2.2		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.022	0.088	26	100

*TPH referenced to Jet Fuel (MW=156)

AIR TOXICS LTD.

SAMPLE NAME: Vent Well
ID#: 9209042-07A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091015		Date of Collection: 9/1/92	
Dil. Factor:	2.2		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.007	0.30	0.94
Toluene	0.002	0.008	0.084	0.31
Total Xylenes	0.002	0.009	0.12	0.51
Ethyl Benzene	0.002	0.009	0.034	0.14

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	6091015		Date of Collection: 9/1/92	
Dil. Factor:	2.2		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.022	0.088	36	140

*TPH referenced to Jet Fuel (MW=156)

AIR TOXICS LTD.

SAMPLE NAME: Power Plant Vent Well
ID#: 9209042-08A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091016		Date of Collection: 9/1/92	
Dil. Factor:	2.1		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.007	0.066	0.21
Toluene	0.002	0.008	0.30	1.1
Total Xylenes	0.002	0.009	1.0	4.2
Ethyl Benzene	0.002	0.009	0.35	1.5

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	6091016		Date of Collection: 9/1/92	
Dil. Factor:	2.1		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.021	0.084	190	760

*TPH referenced to Gasoline (MW=100)

AIR TOXICS LTD.

SAMPLE NAME: Monitor Point C blue
ID#: 9209042-09A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091017		Date of Collection: 9/1/92	
Dil. Factor:	2.1		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.007	Not Detected	Not Detected
Toluene	0.002	0.008	0.019	0.070
Total Xylenes	0.002	0.009	0.052	0.22
Ethyl Benzene	0.002	0.009	0.005	0.021

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	6091017		Date of Collection: 9/1/92	
Dil. Factor:	2.1		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.021	0.084	10	40

*TPH referenced to Gasoline (MW=100)

AIR TOXICS LTD.

SAMPLE NAME: Power Plant MPA Red
ID#: 9209042-10A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	**6091018**		**Date of Collection: 9/1/92**	
Dil. Factor:	**110**		**Date of Analysis: 9/10/92**	
Compound	**MDL (ppmv)**	**MDL (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
Benzene	0.11	0.34	Not Detected	Not Detected
Toluene	0.11	0.40	1.1	4.0
Total Xylenes	0.11	0.47	7.4	31
Ethyl Benzene	0.11	0.47	1.8	7.6

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	**6091018**		**Date of Collection: 9/1/92**	
Dil. Factor:	**110**		**Date of Analysis: 9/10/92**	
Compound	**MDL (ppmv)**	**MDL (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
TPH*	1.1	4.4	1100	4400

*TPH referenced to Gasoline (MW=100)

AIR TOXICS LTD.

SAMPLE NAME: MPA Red, Little or No Vacuum Flow
ID#: 9209042-11A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091105		Date of Collection: 9/1/92	
Dil. Factor:	2.0		Date of Analysis: 9/11/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.006	0.014	0.044
Toluene	0.002	0.007	0.033	0.12
Total Xylenes	0.002	0.008	0.22	0.93
Ethyl Benzene	0.002	0.008	0.006	0.025

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	6091105		Date of Collection: 9/1/92	
Dil. Factor:	2.0		Date of Analysis: 9/11/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.020	0.080	1.4	5.6

*TPH referenced to Gasoline (MW=100)

AIR TOXICS LTD.

SAMPLE NAME: MPA Red
ID#: 9209042-12A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091106		Date of Collection: 9/1/92	
Dil. Factor:	520		Date of Analysis: 9/11/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.52	1.6	120	370
Toluene	0.52	1.9	22	81
Total Xylenes	0.52	2.2	18	76
Ethyl Benzene	0.52	2.2	6.8	29

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	6091106		Date of Collection: 9/1/92	
Dil. Factor:	520		Date of Analysis: 9/11/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	5.2	21	6700	27000

*TPH referenced to Gasoline (MW=100)

AIR TOXICS LTD.

SAMPLE NAME: MPA Red Duplicate
ID#: 9209042-12B

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091107		Date of Collection: 9/1/92	
Dil. Factor:	520		Date of Analysis: 9/11/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.52	1.6	110	340
Toluene	0.52	1.9	22	81
Total Xylenes	0.52	2.2	18	76
Ethyl Benzene	0.52	2.2	6.6	28

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	6091107		Date of Collection: 9/1/92	
Dil. Factor:	520		Date of Analysis: 9/11/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	5.2	21	6400	26000

*TPH referenced to Gasoline (MW=100)

AIR TOXICS LTD.

SAMPLE NAME: Method Spike
ID#: 9209042-13A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091101		Date of Collection: NA
Dil. Factor:	1.0		Date of Analysis: 9/11/92
Compound	MDL (ppmv)	MDL (uG/L)	% Recovery
Benzene	0.001	0.003	112
Toluene	0.001	0.004	111
Total Xylenes	0.001	0.004	110
Ethyl Benzene	0.001	0.004	109

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	6091102		Date of Collection: NA
Dil. Factor:	1.0		Date of Analysis: 9/11/92
Compound	MDL (ppmv)	MDL (uG/L)	% Recovery
TPH*	0.010	0.040	90

*TPH referenced to Gasoline (MW=100)

AIR TOXICS LTD.

SAMPLE NAME: Lab Blank
ID#: 9209042-14A

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091104		Date of Collection: NA	
Dil. Factor:	1.0		Date of Analysis: 9/11/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	6091104		Date of Collection: NA	
Dil. Factor:	1.0		Date of Analysis: 9/11/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.010	0.040	Not Detected	Not Detected

*TPH referenced to Gasoline (MW=100)

AIR TOXICS LTD.

SAMPLE NAME: Lab Blank
ID#: 9209042-14B

EPA Method TO-3
(Aromatic Volatile Organics in Air)

BTXE BY GC/PID

File Name:	6091004		Date of Collection: NA	
Dil. Factor:	1.0		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name:	6091004		Date of Collection: NA	
Dil. Factor:	1.0		Date of Analysis: 9/10/92	
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.010	0.040	Not Detected	Not Detected

*TPH referenced to Gasoline (MW=100)

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. _____

Proj. No.	Project Title	SAMPLE TYPE (√)	Container No.	Number of Containers	Remarks
SAMPLERS: (Signature)					

DATE	TIME	SAMPLE I.D.																	

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	

Page _____ of _____

ENGINEERING-SCIENCE, INC.

RESEARCH AND DEVELOPMENT
LABORATORY
600 BANCROFT WAY
BERKELEY, CALIFORNIA 94710
(415) 841-7353

Report Date: October 9, 1992

Work Order No.:4269

Client: Jeff Kittel
Battelle
505 King Ave.
Columbus, OH 43201

Date of Sample Receipt: 08/25/92

Your soil samples identified as:

CA-V-4.0
CA-V-6.0
CA-V-9.0
GA1-V-2.5
GA1-V-5.5
GA1-V-8.0
GA2-V-4.0
GA2-V-5.5
GA2-V-11.5

were analyzed for BTEX by EPA Method 8020, pH, alkalinity, iron, total Kjeldahl nitrogen, moisture, TRPH by EPA Method 418.1 and total phosphours.

The analytical reports for the samples listed above are attached.

GC VOLATILES DATA PACKAGE

BTEX CASE NARRATIVE
WORK ORDER NO. 4269
EPA METHOD 8020

These nine soil samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) by EPA Method 8020. ESBL selected compounds and spiking amounts were used for the surrogates and matrix spike/spike duplicates. ESBL QC acceptance criteria were used for the surrogates; ESBL QC acceptance criteria were used for the matrix spike/spike duplicates.

All analytes found at concentrations greater than ESBL method detection limits were quantitated on a second dissimilar column.

All samples were analyzed within EPA Data Validation Technical Holding Times with the exception of the second column confirmation of sample GA-V-9.0 (4269-3). The primary result was analyzed within holding time.

Six blanks were analyzed with these samples and met method acceptance criteria for surrogates and contamination.

The continuing calibration checks used for quantifying these samples met method acceptance criteria.

All surrogate recoveries were within ESBL acceptance criteria.

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 11.23

Client ID:CTP 9/24 A-V-4.0 Matrix:SOIL

Laboratory ID:4269-1 Level:LOW

Unit:ug/KG

Dilution Factor: 5 Date Analyzed:08/28/92
Date Confirmed:09/02/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	3.4
Ethyl Benzene	ND	ND	2.8
Toluene	ND	ND	3.9
Xylenes (total)	33.0	90.0	5.1

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST:AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 5.85

Client ID:GA-V-6.0 TP 9/24 Matrix:SOIL

Laboratory ID:4269-2 Level:LOW

Unit:ug/KG

Dilution Factor: 5 Date Analyzed:08/28/92
Date Confirmed:09/02/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	3.2
Ethyl Benzene	ND	ND	2.6
Toluene	46.0	740.0	3.7
Xylenes (total)	340.0	470.0	4.8

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER: Russell

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 19.68

C TP 9/24/92
Client ID:CA-V-9.0 Matrix:SOIL

Laboratory ID:4269-3 Level:LOW

Unit:ug/KG

Dilution Factor: 2 Date Analyzed:08/28/92
Date Confirmed:09/04/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	43.0	85.0	1.5
Ethyl Benzene	ND	ND	1.2
Toluene	ND	ND	1.7
Xylenes (total)	11.0	92.0	2.2

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER: [signature]

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 20.26

Client ID:GA1-V-2.5 Matrix:SOIL

Laboratory ID:4269-4 Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:08/31/92
Date Confirmed:09/02/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	75.0
Ethyl Benzene	ND	ND	63.0
Toluene	600.0	1000.0	88.0
Xylenes (total)	3600.0	1200.0	110.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 24.84

Client ID:GA1-V-5.5 Matrix:SOIL

Laboratory ID:4269-5 Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:08/31/92
Date Confirmed:09/02/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	80.0
Ethyl Benzene	ND	ND	66.0
Toluene	850.0	420.0	93.0
Xylenes (total)	4800.0	3000.0	120.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST:AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 20.71

Client ID:GA1-V-8.0 Matrix:SOIL

Laboratory ID:4269-6 Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:09/03/92
Date Confirmed:09/03/92

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	76.0
Ethyl Benzene	ND	ND	63.0
Toluene	690.0	480.0	88.0
Xylenes (total)	2700.0	960.0	110.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: [illegible] GROUP LEADER: [illegible]

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 23.5

Client ID:GA2-V-4.0 Matrix:SOIL

Laboratory ID:4269-7 Level:LOW

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:08/28/92
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.8
Ethyl Benzene	ND	ND	0.6
Toluene	ND	ND	0.9
Xylenes (total)	ND	ND	1.2

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 22.57

Client ID:GA2-V-5.5 Matrix:SOIL

Laboratory ID:4269-8 Level:LOW

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:08/28/92
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.8
Ethyl Benzene	ND	ND	0.6
Toluene	ND	ND	0.9
Xylenes (total)	ND	ND	1.2

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 20.47

Client ID:GA2-V-11.5 Matrix:SOIL

Laboratory ID:4269-9 Level:LOW

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:08/28/92
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.8
Ethyl Benzene	ND	ND	0.6
Toluene	ND	ND	0.9
Xylenes (total)	ND	ND	1.1

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture: 0

Client ID:(BLANK) Matrix:SOIL

Laboratory ID:MSVG3920902B Level:NA

Sample wt./vol : 5 gm. Unit:ug/Kg

Dilution Factor: 1 Date Analyzed:09-02-92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	0.8
Ethyl Benzene	ND	0.6
Toluene	ND	0.9
Xylenes (total)	ND	1.2

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: [signature] GROUP LEADER: [signature]

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MWVG3920902B Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:09/02/92
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AM GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MWVG5920903 Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:09/03/92
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MWVG3920903B Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:09/03/92
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reportin Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MWVG3920904B Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:09/04/92
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reportin Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MSVG5920828 Level:LOW

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:08/28/92
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	0.6
Ethyl Benzene	ND	ND	0.5
Toluene	ND	ND	0.7
Xylenes (total)	ND	ND	0.9

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
8020 Aromatic Compounds

Work Order NO.:4269 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MWVG5920831 Level:MEDIUM

Unit:ug/KG

Dilution Factor: 1 Date Analyzed:08/31/92
Date Confirmed:NA

Compound	Primary Result	Confirmatory Result	Reporting Limit
Benzene	ND	ND	60.0
Ethyl Benzene	ND	ND	50.0
Toluene	ND	ND	70.0
Xylenes (total)	ND	ND	90.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB GROUP LEADER:

ES-ENGINEERING SCIENCE,INC.

600 BANCROFT WAY
BERKELEY, CA 94710

GC ANALYTICAL REPORT
ANALYTICAL REPORT
BTEX AROMATIC COMPOUNDS

MATRIX: MEDIUM SOIL COLUMN ID: VGC-5 DB-624 DATE:08/31/92 & 09/03/92

LABORATORY NO.	CLIENT ID	a-a-a-TriFluoro Toluene
MWVG5920831	METHOD BLANK	101
MWVG5920903	METHOD BLANK	99
4269-4	GA1-V-2.5	116
4269-5	GA1-V-5.5	130
4269-6	GA1-V-8.0	130

ES-ENGINEERING SCIENCE,INC.
600 BANCROFT WAY
BERKELEY, CA 94710

GC ANALYTICAL REPORT
ANALYTICAL REPORT
BTEX AROMATIC COMPOUNDS

MATRIX: SOIL COLUMN ID: VGC-5 DB-624 DATE:08/28/92

LABORATORY NO.	CLIENT ID	a-a-a-TriFluoro Toluene
MSVG5920828	METHOD BLANK	104
4269-1	CA-V-4.0	126
4269-2	CA-V-6.0	122
4269-3	CA-V-9.0	117
4269-7	GA2-V-4.0	117
4269-8	GA2-V-5.5	117
4269-9	GA2-V-11.5	110

ES-ENGINEERING SCIENCE,INC.

600 BANCROFT WAY
BERKELEY, CA 94710

GC ANALYTICAL REPORT
ANALYTICAL REPORT
BTEX AROMATIC COMPOUNDS

MATRIX: ~~MEDIUM~~ SOIL (TP 9/24) COLUMN ID: VGC-3 VOCOL DATE:09/02-04/92

LABORATORY NO.	CLIENT ID	a-a-a-TriFluoro Toluene
MWVG3920902A	METHOD BLANK	114
MWVG3920903B	METHOD BLANK	103
MWVG3920904B	METHOD BLANK	118
SWVG3920902A	SPIKE	106
SWVG3920902B	SPIKE DUPLICATE	105
4269-1	CA-V-4.0	104
4269-2	CA-V-6.0	72
4269-4	GA1-V-2.5	54
4269-5	GA1-V-5.5	51
4269-3	CA-V-9.0	116
4269-6	GA1-V-8.0	78

METHOD BLANK SUMMARY

WO # 4269

LAB NAME : ENGINEERING-SCIENCE, INC.
DATE ANALYZED :08/31/92&
:09/03/92

LAB SAMPLE ID:MWVG5920831(0903)
DATE EXTRACTED : NA

MATRIX :MEDIUM SOIL
INSTRUMENT ID:VGC-5

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MWVG5920831	METHOD BLANK	08/31/92
4269-4	GA1-V-2.5	08/31/92
4269-5	GA1-V-5.5	08/31/92
4269-6	GA1-V-8.0	09/03/92
MWVG5920903	METHOD BLANK	09/03/92

METHOD BLANK SUMMARY

WO # 4269

LAB NAME : ENGINEERING-SCIENCE, INC. DATE ANALYZED :08/28/92

LAB SAMPLE ID:MSVG5920828 DATE EXTRACTED : NA

MATRIX :SOIL INSTRUMENT ID:VGC-5

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MSVG5920828	METHOD BLANK	08/28/92
4269-1	CA-V-4.0	08/28/92
4269-2	CA-V-6.0	08/28/92
4269-3	CA-V-9.0	08/28/92
4269-7	GA2-V-4.0	08/28/92
4269-8	GA2-V-5.5	08/28/92
4269-9	GA2-V-11.5	08/28/92

METHOD BLANK SUMMARY

WO # 4269

LAB NAME : ENGINEERING-SCIENCE, INC. DATE ANALYZED :09/02-04/92

LAB SAMPLE ID:MWVG39209(02-04) DATE EXTRACTED : NA

TP 9/24

MATRIX :~~MEDIUM~~ SOIL INSTRUMENT ID:VGC-3

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MWVG3920902B	METHOD BLANK	09/02/92
MWVG3920903B	METHOD BLANK	09/03/92
MWVG3920904B	METHOD BLANK	09/04/92
SWVG3920902A	SPIKE	09/02/92
SWVG3920902B	SPIKE DUPLICATE	09/02/92
4269-1	CA-V-4.0	09/02/92
4269-2	CA-V-6.0	09/02/92
4269-3	CA-V-9.0	09/04/92
4269-4	GA1-V-5.5	09/02/92
4269-5	GA1-V-5.5	09/02/92
4269-6	GA1-V-8.0	09/03/92

TOTAL RECOVERABLE PETROLEUM HYDROCARBONS
DATA PACKAGE

CASE NARRATIVE
WORK ORDER NO.4269
TRPH - 418.1 SOILS

Samples CA-V-4.0 (4269-01), CA-V-6.0 (4269-02) and CA-V-9.0 (4269-03) were analyzed six days past holding time.

Samples GA1-V-2.5 (4269-04), GA1-V-5.5 (4269-05) and GA1-V-8.0 (4269-06) were analyzed five days past holding time.

Samples GA2-V-4.0 (4269-07), GA2-V-5.5 (4269-08) and GA2-V-11.5 (4269-09) were analyzed four days past holding time.

All samples were extracted within the 28 day extraction period.

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way
Berkeley,CA 94710

ORGANIC ANALYTICAL REPORT

Work Order NO.: 4269

Matrix: Soil

Parameter: TPH

Unit: mg/Kg

Analytical Method: 418.1

Date Extracted: 09/15/92

QC Batch NO.: S92QCB022TPH

Date Analyzed: 09/22/32

Sample ID:	Client ID:	Result	Reporting Limit	Percent Moisture
4269-01	GA-V-4.0	180	5	11.2
4269-02	GA-V-6.0	1700	4	5.9
4269-03	GA-V-9.0	390	5	19.7
4269-04	GA1-V-2.5	420	5	20.3
4269-05	GA1-V-5.5	300	5	24.8
4269-06	GA1-V-8.0	85	5	20.7
4269-07	GA2-V-4.0	51	5	23.5
4269-08	GA2-V-5.5	61	5	22.6
4269-09	GA2-V-11.5	180	5	20.5
MSTPH920915	METHOD BLANK	ND	4	NA

NA_ Not Analyzed
ND_ Not Detected

ANALYST:

GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.

600 Bancroft Way
Berkeley. CA 94710

ORGANIC QUALITY CONTROL RESULTS SUMMARY
Blank Spike/Spike Duplicate

Work Order NO.: 4269

QC Sample NO.: SSTPH920903A & B Analytical Method: 418.1

Blank I.D.: MSTPH920903 Matrix: Soil

QC Batch NO.: S92QCB022TPH Unit: mg/Kg

Parameter	Date Analyzed	BR	SA	BS	PR	BSD	PR	RPD
TPH	09/04/92	0	165	176	107	176	107	0

BS-Blank Spike
BSD-Blank Spike Duplicate
SA-Spike Added
BR_Blank Result
NA-Not Applicable
NC-Not Calculated
ND-Not Detected

RPD=((BS-BSD)/((BS+BSD)/2))*100

PR=((BS OR BSD -BR)/SA)*100

ANALYST:

QUALITY CONTROL:

INORGANICS DATA PACKAGE

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: Battelle

Work Order: 4269
Matrix: Solid

Client's ID:	CA-V-4.0	CA-V-6.0	CA-V-9.0
Sample Date:	08/19/92	08/19/92	08/19/92
% Moisture:			
Lab ID:	4269.01	4269.02	4269.03

Parameter	Results			Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	230.	190.	490.	SM 403(M)	50	mg/Kg CaCO3	09/04/92
Moisture	11.2	5.9	19.7	ASTM D2216	.1	% by wt	09/04/92
pH	8.3	8.3	7.6	EPA 9045	NA	pH Units	08/28/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Gleaton

GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: Battelle

Work Order: 4269
Matrix: Solid

Client's ID: GA1-V-2.5 GA1-V-5.5 GA1-V-8.0

Parameter	Results			Method	Normal Report Limit	Units	Date Analyzed
Sample Date:	08/20/92	08/20/92	08/20/92				
% Moisture:							
Lab ID:	4269.04	4269.05	4269.06				
Alkalinity	400.	670.	500.	SM 403(M)	50	mg/Kg CaCO3	09/04/92
Moisture	20.3	24.8	20.7	ASTM D2216	.1	% by wt	09/04/92
pH	7.8	7.4	7.4	EPA 9045	NA	pH Units	08/28/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Sleator

GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.
600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: Battelle
Work Order: 4269
Matrix: Solid

Client's ID: GA2-V-4.0 GA2-V-5.5 GA2-V-11.5

Sample Date: 08/21/92 08/21/92 08/21/92
% Moisture:
Lab ID: 4269.07 4269.08 4269.09

Parameter	Results			Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	480.	500.	500.	SM 403(M)	50	mg/Kg CaCO3	09/04/92
Moisture	23.5	22.6	20.5	ASTM D2216	.1	% by wt	09/04/92
pH	7.7	7.8	7.8	EPA 9045	NA	pH Units	08/28/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Gleaton GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: Battelle

Work Order: 4269
Matrix: Solid

Client's ID: Prep Blank

Sample Date:
% Moisture:
Lab ID: Prep Blank

Parameter	Results	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	SM 403(M)	50	mg/Kg CaCO3	09/04/92
Moisture	NA	ASTM D2216	.1	% by wt	09/04/92
pH	NA	EPA 9045	NA	pH Units	08/28/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Sleaton

GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANICS QC SUMMARY - LAB CONTROL SAMPLE

Work Order: 4269

% Moisture: NA

Lab ID of LCS:
Alkalinity: 452.20 LCS

Matrix: Solid

Units: mg/Kg CaCO3

Parameter	Date Analyzed LCS	LCS Result	Conc Added	% Rec LCS	Advisory Limits -- % Rec -- Low	High
Alkalinity	09/04/92	23050.00	23650.00	97	80	120

ANALYST: Don Gleaton Date 9/09/92 REVIEWER: _____ Date 9/16/92

File:M1QCLCSW

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANIC QC SUMMARY - MS and MSD

Work Order: 4269

% Moisture: NA

Matrix: Solid

Units: mg/Kg CaCO3 (Alk)
% by wt. (Mois)
pH Units (pH)

	Alkalinity	Moisture	pH
Lab ID Spk/Dup:	Blank Spk	4269.01	4254.01
QC Batch:	452.21	451.50	453.30

Parameter	Date Analyzed MS/Dup	Unspiked Sample	MS/Sample	MSD/Dup	RPD	RPD QC Limit	-Conc Added- MS	MSD	Percent Recovered MS	MSD
Alkalinity	09/04/92	0.00	23050.00	23100.00	0	20	23650.00	23650.00	97	98
Moisture	09/04/92		11.23	11.05	2	20				
pH	08/28/92		8.11	8.06	1	20				

* or N = Outside QC Limit:

QC Limits for % Rec: 75 - 125

ANALYST: Don Gleaton Date 9/09/92 REVIEWER: _____ Date 9/10/92

File:M1QCKSWM

METALS DATA PACKAGE

CASE NARRATIVE
WORK ORDER NO.4269
METALS-SOILS

The concentration of iron in sample N3V6-7 was greater than four times the spike added to the MS and MSD samples. The LCS and duplicate LCS results for iron were checked, and the laboratory was found to be in control. All iron results in this batch are therefore reported unqualified based on matrix spike recovery.

Client ID's were abridged by the laboratory to facilitate computer entry of analytical data. The following should be used as a reference:

CLIENT ID	ABRIDGED ID
CA-V-4.0	CA40
CA-V-6.0	CA60
CA-V-9.0	CA90
GA1-V-2.5	GA125
GA1-V-5.5	GA155
GA1-V-8.0	GA180
GA2-V-4.0	GA240
GA2-V-5.5	GA255
GA2-V-11.5	GA2115

Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID: CA40

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: 4269.01___

Level (low/med): LOW__ Date Received: 08/25/92

% Solids: _88.8

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	15800			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID: CA60

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: 4269.02___

Level (low/med): LOW__ Date Received: 08/25/92

% Solids: _94.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	11000			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID: CA90

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: 4269.03___

Level (low/med): LOW__ Date Received: 08/25/92

% Solids: _80.3

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	18700			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID: GA125

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: 4269.04___

Level (low/med): LOW__ Date Received: 08/25/92

% Solids: _79.7

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	20300			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

GA155

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: 4269.05___

Level (low/med): LOW__ Date Received: 08/25/92

% Solids: _75.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	24500			P

Comments:

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Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

GA180

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: 4269.06___

Level (low/med): LOW__ Date Received: 08/25/92

% Solids: _79.3

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	19500			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

GA240

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: 4269.07___

Level (low/med): LOW__ Date Received: 08/25/92

% Solids: _76.5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	27700			P

Comments:

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Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID: GA255

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: 4269.08___

Level (low/med): LOW__ Date Received: 08/25/92

% Solids: _77.4

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	19900			P

Comments:

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Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

GA2115

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: 4269.09___

Level (low/med): LOW__ Date Received: 08/25/92

% Solids: _79.5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	24900			P

Comments:

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Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID: PBLANK

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Lab Sample ID: PBK 460.94

Level (low/med): LOW__ Date Received: 09/01/92

% Solids: 100.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	8.9			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

SPIKE SAMPLE RECOVERY

CLIENT SAMPLE ID: N3V6-7S2

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL__ Level (low/med): LOW__

Solids for Sample: _85.4

Concentration Units (ug/L or mg/kg dry weight):MG/KG

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
Iron		20309.9594		16887.7056		77.55	4413.0		P

Comments:

FORM V (Part 1) - IN 3/90

Engineering Science - Berkeley Laboratory
Inorganics Report

SPIKE SAMPLE RECOVERY

CLIENT SAMPLE ID

N3V6-7S1

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL__ Level (low/med): LOW__

% Solids for Sample: _85.4

Concentration Units (ug/L or mg/kg dry weight):MG/KG

Analyte	Control Limit %R	Spiked Sample Result (SSR)	C	Sample Result (SR)	C	Spike Added (SA)	%R	Q	M
Iron		18473.1403		16887.7056		77.04	2057.9		P

Comments:

FORM V (Part 1) - IN 3/90

Engineering Science - Berkeley Laboratory
Inorganics Report

MATRIX SPIKE DUPLICATE

CLIENT SAMPLE ID

N3V6-7SD

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Level (low/med): _LOW__

% Solids for Sample: _85.4 % Solids for Duplicate: _85.6

Concentration Units (ug/L or mg/kg dry weight):MG/KG

Analyte	Control Limit	Sample Spike (S)	C	Sample Spike Duplicate (D)	C	RPD	Q	M
Iron		18473.1403		20309.9594		9.5		P

Engineering Science - Berkeley Laboratory
Inorganics Report

BLANK SPIKE SAMPLE

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Solid LCS Source: ESBL-LCSS___

Aqueous LCS Source: _____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Iron				100.0	110.2		80.0	120.0	110.2

FORM VII - IN

3/90

Inorganics Report

BLANK SPIKE SAMPLE

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Solid LCS Source: ESBL-LCSS___

Aqueous LCS Source: _____

Analyte	Aqueous (ug/L) True	Found	%R	Solid (mg/kg) True	Found	C	Limits		%R
Iron				100.0	102.5		80.0	120.0	102.5

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Engineering Science - Berkeley Laboratory
Inorganics Report

BLANK SPIKE DUPLICATE

CLIENT SAMPLE ID

LCSSD

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Level (low/med): _LOW__

% Solids for Sample: 100.0 % Solids for Duplicate: 100.0

Concentration Units (ug/L or mg/kg as received): MG/KG

Analyte	Control Limit	Blank Spike (S)	C	Blank Spike Duplicate (D)	C	RPD	Q	M
Iron		110.1810		102.5490		7.2		P

Inorganic Report

ICP SERIAL DILUTION

EPA SAMPLE NO.

N3V6-7L

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S_ SAS No.: _____ SDG No.: CA40__

Matrix (soil/water): SOIL_ Level (low/med): LOW__

Concentration Units: ug/L

Analyte	Initial Sample Result (I)	C	Serial Dilution Result (S)	C	% Difference	Q	M
Iron	262482.23		289908.36		10.4		P

Engineering Science - Berkeley Laboratory

Method Detection Limits (Annually)

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S_ SAS No.: _____ SDG No.: CA40__

ICP ID Number: TJA_61_____M Date: 09/01/92

Flame AA ID Number : _____ Matrix: SOIL_

Furnace AA ID Number : _____ (ug/L in 1.00g to 100ml digestate)

Analyte	Wave-length (nm)	Back-ground		MDL (ug/L)	M
Iron	271.44			47.0	P

Comments:

FORM X - IN

ILMO2.

Engineering Science - Berkeley Laboratory
Inorganics Report

PREPARATION LOG

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.:_4254S_ SAS No.: _____ SDG No.:CA40__

Method: P_

EPA Sample No.	Preparation Date	Weight (gram)	Volume (mL)
CA40	09/01/92	1.61	100
CA60	09/01/92	1.47	100
CA90	09/01/92	1.83	100
GA125	09/01/92	1.62	100
GA155	09/01/92	1.53	100
GA180	09/01/92	1.86	100
GA2115	09/01/92	1.63	100
GA240	09/01/92	1.84	100
GA255	09/01/92	1.87	100
LCSS	09/01/92	1.00	100
LCSSD	09/01/92	1.00	100
N3A2-3	09/01/92	1.62	100
N3A6-7	09/01/92	1.88	100
N3V6-7	09/01/92	1.82	100
N3V6-7S1	09/01/92	1.52	100
N3V6-7S2	09/01/92	1.51	100
PBLANK	09/01/92	1.00	100

Inorganics Report

ANALYSIS RUN LOG

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S_ SAS No.: _____ SDG No.:CA40__

Instrument ID Number: TJA 61 M_ Method: P_

Start Date: 09/03/92 End Date: 09/03/92

EPA Sample No.	D/F	Time	% R	Analytes FE
ICSA	1.00	1955		X
ICSAB	1.00	2000		X
CRI	1.00	2005		
CCV	1.00	2009		X
CCB	1.00	2014		X

Inorganics Report

ANALYSIS RUN LOG

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4254S_ SAS No.: _____ SDG No.:CA40__

Instrument ID Number: TJA 61 M_ Method: P_

Start Date: 09/03/92 End Date: 09/03/92

EPA Sample No.	D/F	Time	% R	Analytes FE
TD1	1.00	1728		X
STD2	1.00	1732		X
TD3	1.00	1737		X
TD4	1.00	1742		X
ICV	1.00	1746		X
ICB	1.00	1751		X
CSA	1.00	1756		X
CSAB	1.00	1800		X
CRI	1.00	1805		
BLANK	1.00	1809		X
ZZZZZ	1.00	1814		
LCSS	1.00	1819		X
LCSSD	1.00	1823		X
V6-7	1.00	1828		X
N3V6-7S1	1.00	1832		X
N3V6-7S2	1.00	1837		X
CV	1.00	1842		X
CCB	1.00	1846		X
N3V6-7L	1.00	1851		X
A2-3	1.00	1855		X
A6-7	1.00	1900		X
CA40	1.00	1905		X
GA60	1.00	1909		X
GA90	1.00	1914		X
GA125	1.00	1919		X
GA155	1.00	1923		X
CV	1.00	1928		X
CCB	1.00	1932		X
GA180	1.00	1937		X
GA240	1.00	1942		X
GA255	1.00	1946		X
GA2115	1.00	1951		X

TOTAL KJELDAHL NITROGEN
TOTAL PHOSPHATE

DATA PACKAGE

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.	Client Project ID:	W.O. #4269	Sampled:	8/19-21/92
600 Bancroft Way	Sample Descript:	Soil	Received:	Aug 26, 1992
Berkeley, CA 94710	Analysis for:	Total Kjeldahl Nitrogen	Analyzed:	Sep 3, 1992
Attention: Tom Paulson	First Sample #:	208-4341	Reported:	Sep 17, 1992

LABORATORY ANALYSIS FOR: Total Kjeldahl Nitrogen

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
208-4341	CAV-4	20	510
208-4342	CAV-6	20	430
208-4343	CAV-9	20	1,200
208-4344	GA1-V-2.5	20	800
208-4345	GA1-V-5.5	20	800
208-4346	GA1-V-8.0	20	800
208-4347	GA2-V-4	20	700
208-4348	GA-V-5.5	20	670
208-4349	GA2-V-11.5	20	490
-	Method Blank	20	N.D.

THIS REPORT HAS BEEN APPROVED AND REVIEWED BY

Dawson 10/5/92

ESBL PROJECT MANAGER DATE

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

Please Note:

Analysis results reported on a dry-weight basis.

This report amended 9/23/92.

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.	Client Project ID:	W.O. #4269	Sampled:	8/19-21/92
600 Bancroft Way	Sample Descript:	Soil	Received:	Aug 26, 1992
Berkeley, CA 94710	Analysis for:	Total Phosphorous	Analyzed:	Sep 15, 1992
Attention: Tom Paulson	First Sample #:	208-4341	Reported:	Sep 17, 1992

LABORATORY ANALYSIS FOR: Total Phosphorous

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
208-4341	CAV-4	10	510
208-4342	CAV-6	10	510
208-4343	CAV-9	10	690
208-4344	GA1-V-2.5	10	670
208-4345	GA1-V-5.5	10	720
208-4346	GA1-V-8.0	10	790
208-4347	GA2-V-4	10	750
208-4348	GA-V-5.5	10	650
208-4349	GA2-V-11.5	10	720
-	Method Blank	10	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

Please Note:
Analysis results reported on a dry-weight basis.

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.
600 Bancroft Way
Berkeley, CA 94710
Attention: Tom Paulson

Client Project ID: W.O. #4269

QC Sample Group: 2084341-49

Reported: Sep 17, 1992

QUALITY CONTROL DATA REPORT

ANALYTE	Total Kjeldahl Nitrogen	Total Phosphorous
Method:	EPA351.4	EPA365.3
Analyst:	G. Kern	K. Follett
Reporting Units:	mg/kg	mg/kg
Date Analyzed:	Sep 3, 1992	Sep 12, 1992
QC Sample #:	209-0162	208-3561
Sample Conc.:	84	210
Spike Conc. Added:	4000	100
Conc. Matrix Spike:	4600	330
Matrix Spike % Recovery:	113	120
Conc. Matrix Spike Dup.:	4600	350
Matrix Spike Duplicate % Recovery:	113	140
Relative % Difference:	0.0	5.9

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

% Recovery:	Conc. of M.S. - Conc. of Sample / Spike Conc. Added	x 100
Relative % Difference:	Conc. of M.S. - Conc. of M.S.D. / (Conc. of M.S. + Conc. of M.S.D.) / 2	x 100

Battelle
Columbus Laboratories

Form No. 1

CHAIN OF CUSTODY RECORD

Proj. No. G4468-0655
Job No. DE28.03

Project Title: Bioventing Initiative; Galena and Campion AFS's, AK.

SAMPLERS: (Signature) [signature] 614-424-6122

DATE	TIME	SAMPLE I.D.	SAMPLE TYPE (√) Soil	Soil	Soil	Container No.	Number of Containers	Remarks
8/20/92	5:00 pm	GA1-V-8.0			✓		1-4oz	PH, Alkalinity, Ir Soil moisture
8/21/92	10:15 am	GA2-V-4.0	✓				1 brs slv	BTEX, TPH
8/21/92	10:15	GA2-V-4.0		✓			1-16oz	TKN, TP
8/21/92	10:15	GA2-V-4.0			✓		1-4oz	PH, Alkalinity, Ir Soil moisture
8/21/92	10:15	GA2-V-5.5	✓				1-brs slv	BTEX, TPH
8/21/92	10:15	GA2-V-5.5		✓	✓		1-16oz	TKN, TP
8/21/92	10:15	GA2-V-5.5	✓		✓		1-4oz	PH, Alkalinity, Ir Soil moisture
8/21/92	10:15	GA2-V-11.5	✓	✓			1 brs slv	BTEX, TPH
8/21/92	10:15	GA2-V-11.5		✓	✓		1-16oz	TKN, TP
8/21/92	10:15	GA2-V-11.5			✓		1-4oz	PH, Alkalinity, Ir Soil moisture

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
[signature]	8/21/92 11:00				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
		[signature]	08/25/92 0910		

Columbus Laboratories

CHAIN OF CUSTODY RECORD

Proj. No. G4468-0015
Job No. DE2628.5

Project Title: Bioventing Initiative: Galena and Campion AFSs, AK

SAMPLERS: (Signature) Jeff Dietrich (614) 424-6122

DATE	TIME	SAMPLE I.D.	SAMPLE TYPE (√) Soil	Soil	Soil	Container No.	Number of Containers	Remarks
8/19/92	2:00 pm	CA-V-4.0	✓				1 brs slv.	BTEX, TPH
8/19/92	2:00 pm	CA-V-4.0		✓			1-16 oz	TKN, TP
8/19/92	2:00 pm	CA-V-4.0			✓		1-4 oz	PH, Alkalinity, Iron, % moist.
8/19/92	2:00 pm	CA-V-6.0	✓				1 brs slv	BTEX, TPH
8/19/92	2:00 pm	CA-V-6.0		✓			1-16 oz	TKN, TP
8/19/92	2:00 pm	CA-V-6.0			✓		1-4 oz	PH, Alkalinity, Iron Soil moist.
8/19/92	2:00 pm	CA-V-9.0	✓				1 brs slv	BTEX, TPH
8/19/92	2:00 pm	CA-V-9.0		✓			1-16 oz	TKN, TP
8/19/92	2:00 pm	CA-V-9.0			✓		1-4 oz	PH, Alkalinity, Iron Soil moisture
~~8/9~~ 8/20/92	2:00 pm	GA1-V-2.5	✓				1 brs slv	BTEX, TPH
8/20/92	5:00 pm	GA1-V-2.5		✓			1-16 oz	TKN, TP
8/20/92	5:00 pm	GA1-V-2.5			✓		1-4 oz	PH, Alkalinity, Iron Soil moisture
8/20/92	5:00 pm	GA1-V-5.5	✓				1 brs slv	BTEX, TPH
8/20/92	5:00 pm	GA1-V-5.5		✓			1-16 oz	TKN, TP
8/20/92	5:00 pm	GA1-V-5.5			✓		1-4 oz	PH, Alkalinity, Iron Soil moisture
8/20/92	5:00 pm	GA1-V-8.0	✓				1 brs slv	BTEX, TPH
8/20/92	5:00 pm	GA1-V-8.0		✓			1-16 oz	TKN, TP

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Jeff Dietrich	8/21/92 11:00				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
			08/25/92 0910		

[redacted] C-O[redacted] NU[redacted]ER [redacted] 1 [redacted] OF [redacted] 1 [redacted]

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

ES JOB NO.	PROJECT NAME/LOCATION
	4269

FIELD CONTACT:

SAMPLERS NAMES & SIGNATURES

E

PRESERVATIVES REQUIRED

ANALYSES REQUIRED

SHIP TO:

DATE	TIME	FIELD SAMPLE IDENTIFIER	TKN & Total Phosphate												REMARKS
8/19/92	2:00	CAV-4. (4269.01C)	/						2084341						Plse. report MS/MSD &
8/19/92	2:00	CAV-6. (4269.02C)	/							42					method blank. Results
8/19/92	2:00	CAV-9 (4269.03C)	/							43					on dry soil basis.
8/20/92	5:00	GA1-V-2.5(4269.04C)	/							44					2 wk TAT. Report
8/20/92	5:00	GA1-V-5.5 (4269.05C)	/							45					to Tom Paulson-CSI
8/20/92	5:00	GA1-V-8.0 (4269.06C)	/							46					Total phosphate by 365.
8/21/92	10:15	GA2-V-4 (4269.07C)	/							47					TKN by 351.2
8/21/92	10:15	GA-V-5.5 (4269.08C)	/							48					Paulson
8/21/92	10:15	GA2-V-11.5 (4269.09C)	/							49					

FIELD CUSTODY RELINQUISHED BY: [signature] DATE: 8/26/92 TIME: 10:15

SHIPPED VIA: AIRBILL # ON RECEIPT: CUSTODY SEALS? _____; TEMP: _____ °C

RECEIVED FOR LABORATORY BY: [redacted] DATE: 8/26/92 TIME: 10:20 AM

RELINQUISHED BY: [redacted] 8/26/92 11:35 AM [signature] 8-26-92 11:3

APPENDIX C

SADDLE TANK FARM SITE SOIL GAS PERMEABILITY DATA

TABLE C-1. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G1-MPA

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	4.0′	7.5′	11.0′		4.0′	7.5′	11.0′
0	0	0	0	16	3.6	3.5	5.9
1	2.5	2.6	5.1	18	3.4	3.4	5.9
2	3.0	3.0	5.5	20	3.4	3.4	5.9
3	3.1	3.2	5.6	22	3.4	3.4	6.0
4	3.1	3.2	5.7	24	3.4	3.4	6.0
5	3.2	3.3	5.7	26	3.4	3.5	6.0
6	3.4	3.4	5.8	28	3.4	3.5	6.0
7	3.4	3.4	5.8	30	3.4	3.5	6.0
8	3.4	3.4	5.9	40	3.4	3.5	6.0
9	3.5	3.5	5.9	50	3.4	3.5	6.0
10	3.4	3.4	5.9	60	3.4	3.5	6.0
12	3.4	3.4	5.9	90	3.5	3.5	6.0
14	3.4	3.4	5.9	120	3.4	3.5	6.0

TABLE C-2. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G1-MPB

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	4.0′	7.5′	11.0′		4.0′	7.5′	11.0′
0	0	0	<0.0	16	1.875	2.9	3.4
1	0.5	1.0	1.5	18	1.90	2.9	3.4
2	1.0	1.5	2.0	20	1.90	2.9	3.4
3	1.3	1.95	2.7	22	1.90	2.9	3.4
4	1.5	2.3	3.0	24	1.90	2.9	3.4
5	1.6	2.5	3.0	26	1.925	2.9	3.4
6	1.7	2.6	3.1	28	1.925	2.9	3.5
7	1.75	2.6	3.2	30	1.925	2.9	3.5
8	1.80	2.7	3.3	40	1.9	2.9	3.4
9	1.8	2.7	3.4	50	1.9	2.9	3.4
10	1.85	2.8	3.4	60	1.875	2.8	3.4
12	1.85	2.9	3.4	90	1.9	2.9	3.5
14	1.875	2.9	3.4	120	2.0	3.0	3.5

TABLE C-3. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G1-MPC

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	4.0′	7.5′	11.0′		4.0′	7.5′	11.0′
0	0	0	0	16	0.12	0.40	1.20
1	0.01	0.04	0.25	18	0.125	0.40	1.20
22.05	0.035	0.15	0.40	20	0.135	0.40	1.25
3.07	0.05	00.20	.50	22	0.130	0.40	1.25
4.0	0.065	0.20	0.70	24	0.130	0.40	1.25
5.0	0.08	0.25	0.80	26	0.130	0.40	1.25
6.0	0.09	0.25	0.90	28	0.130	0.40	1.30
6.55	0.10	0.30	0.95	30	0.135	0.42	1.30
8.0	0.11	0.35	1.0	40	0.130	0.40	1.30
9.0	0.12	0.35	1.05	50	0.125	0.40	1.25
10.16	0.12	0.35	1.10	60	0.120	0.40	1.20
12	0.13	0.35	1.15	90	0.130	0.40	1.30
14	0.12	0.40	1.20	120	0.125	0.40	1.25

APPENDIX D

SADDLE TANK FARM SITE IN SITU RESPIRATION TEST DATA

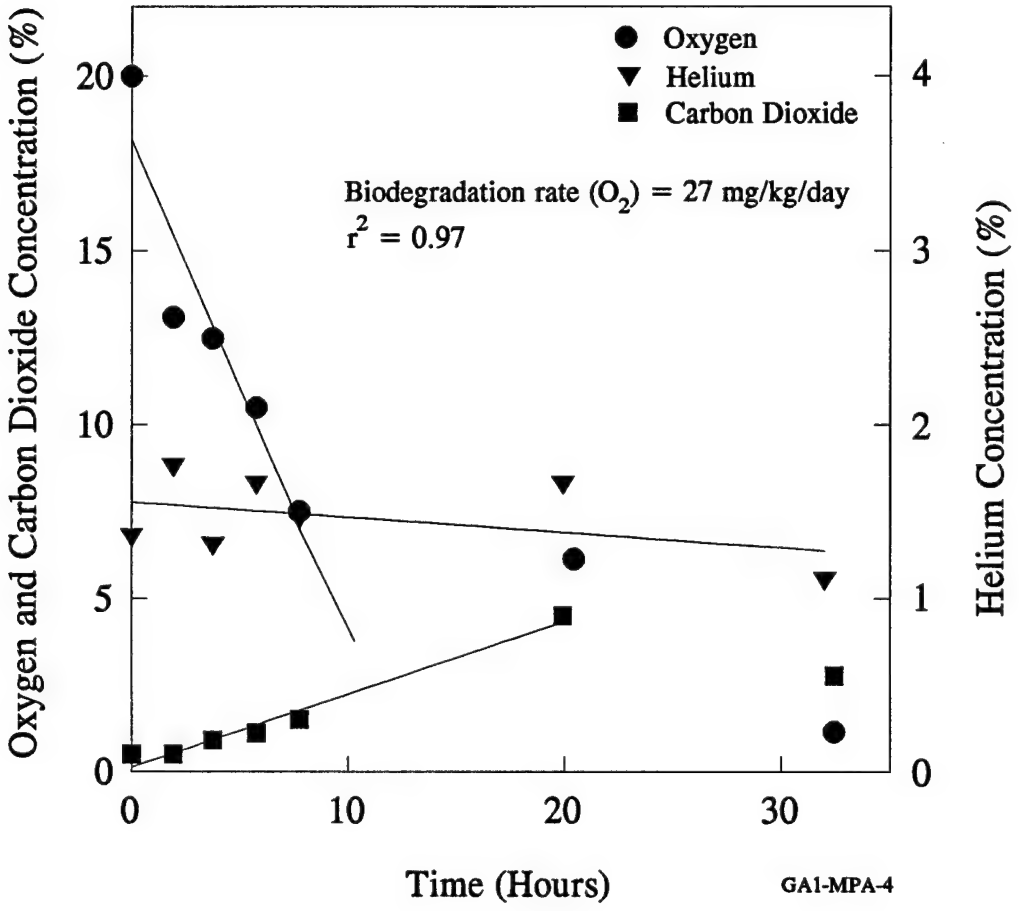

Figure D-1. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G1-MPA-4.0′

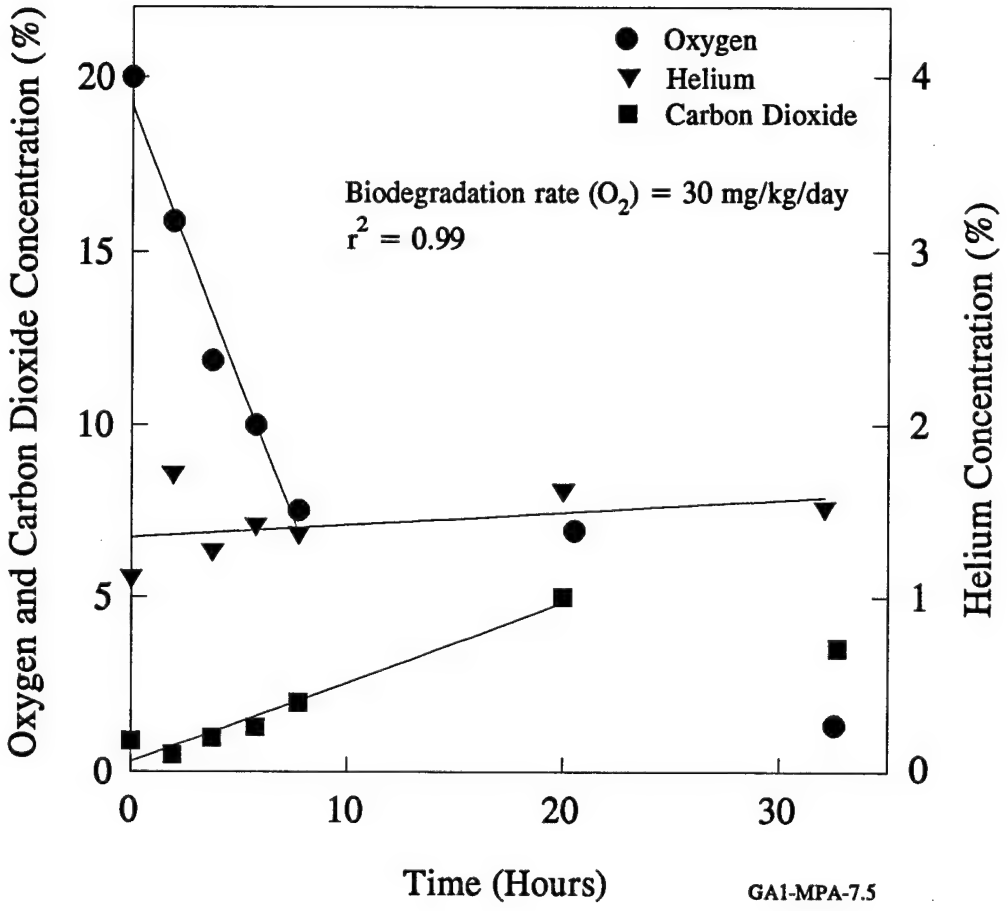

Figure D-2. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G1-MPA-7.5'

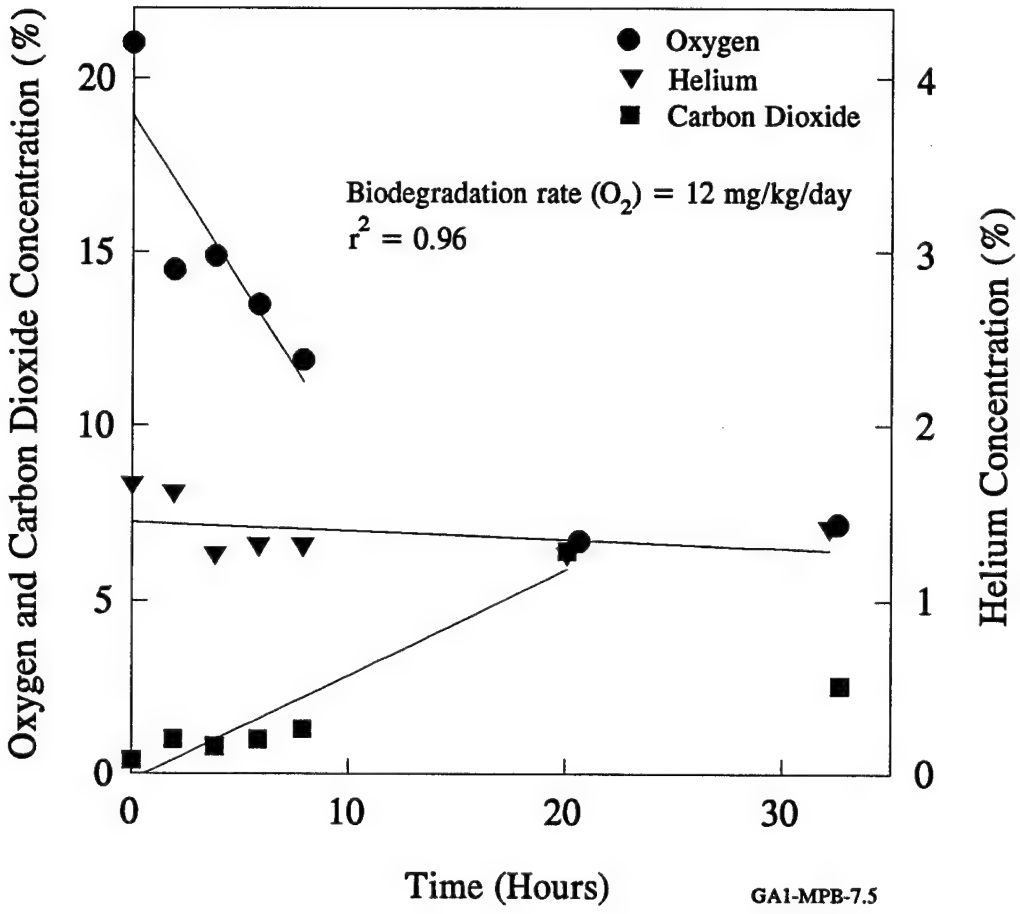

Figure D-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G1-MPB-7.5'

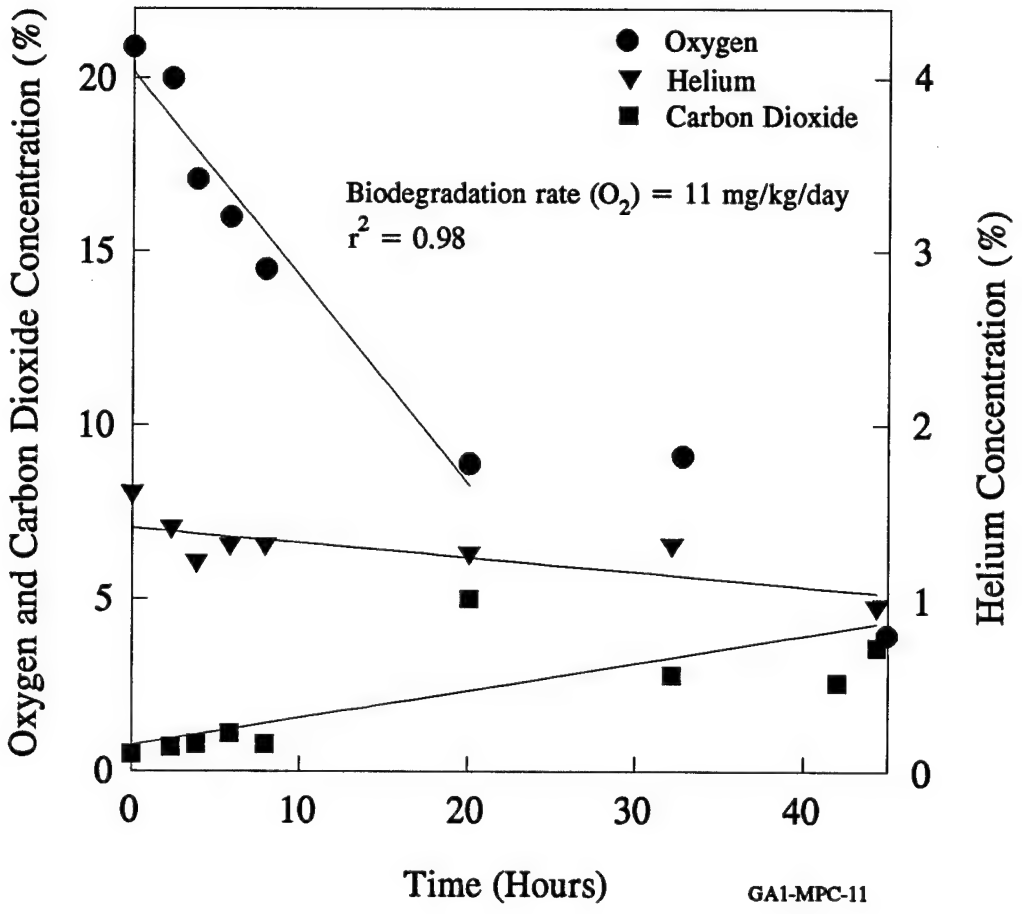

Figure D-4. **Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G1-MPC-11.0′**

APPENDIX E

POWER PLANT SITE SOIL GAS PERMEABILITY DATA

TABLE E-1. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G2-MPA

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	3.0′	5.5′	8.0′		3.0′	5.5′	8.0′
0	0	0	<0	28.1	0.007	0.05	0.08
0.15	0	0.035	0.045	31	0.01	0.045	0.075
3	0	0.04	0.065	35	0.005	0.045	0.08
6	0	0.05	0.07	38.3	0.01	0.045	0.075
8.4	0.01	0.045	0.075	42	0.005	0.048	0.075
11.3	0	0.045	0.077	50	0.008	0.046	0.07
14.4	0.005	0.047	0.075	60	0.005	0.048	0.07
17.3	0.007	0.045	0.065	93	0.008	0.048	0.07
21	0.005	0.045	0.075	120.36	0.011	0.055	0.075
25	0.007	0.05	0.075				

TABLE E-2. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G2-MPB

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	3.0′	5.5′	8.0′		3.0′	5.5′	8.0′
0	0	0	<0	21	0.032	0.031	0.05
1	0.016	0.016	0.02	23	0.031	0.032	0.046
2	0.016	0.016	0.04	25	0.03	0.031	0.054
3	0.02	0.023	0.045	27	0.035	0.036	0.052
4	0.025	0.029	0.05	29	0.031	0.032	0.053
5	0.024	0.025	0.042	31	0.031	0.036	0.055
6	0.024	0.024	0.04	34	0.031	0.32	0.051
8	0.02	0.02	0.045	37	0.029	0.32	0.051
10	0.014	0.02	0.04	40	0.03	0.034	0.05
11	0.03	0.026	0.059	50	0.025	0.026	0.046
13	0.02	0.025	0.05	60	0.027	0.029	0.046
15	0.025	0.026	0.036	90	0.025	0.029	0.046
17	0.036	0.031	0.04	120	0.026	0.028	0.048
19	0.03	0.029	0.05				

TABLE E-3. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G2-MPC

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	3.0′	5.5′	8.0′		3.0′	5.5′	8.0′
0	<0	<0	<0	26.40	0.037	0.045	0.12
2	0.03	0.04	0.09	29.40	0.039	0.047	0.12
4	0.035	0.045	0.11	33	0.036	0.045	0.11
7	0.037	0.045	0.105	37	0.038	0.045	0.11
9.5	0.035	0.04	0.105	40	0.038	0.045	0.115
12.5	0.035	0.042	0.11	52	0.035	0.042	0.105
16	0.035	0.04	0.11	62	0.037	0.041	0.105
19	0.037	0.042	0.11	95	0.035	0.041	0.112
23.4	0.037	0.04	0.11	122.3	0.035	0.042	0.105

TABLE E-4. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G2-MPD

Time (min)	Pressure ("H_2O) by Depth		Time (min)	Pressure ("H_2O) by Depth	
	2.0′	5.5′		2.0′	5.5′
0	0	0	18	0.009	0.010
1	0	0	20	0.010	0.010
2	0	0	22	0.005	0.005
3	0.005	0.005	24	0.010	0.010
4	0.015	0.010	26	0.015	0.010
5	0.015	0.010	28	0.015	0.015
6	0.010	0.015	30	0.015	0.020
7	0.010	0.015	33	0.010	0.020
8	0.010	0.010	36	0.010	0.010
9	0.010	0.010	39	0.005	0.010
10	0.010	0.010	50	0.005	0.010
12	0.009	0.010	60	0.010	0.005
14	0.005	0.010	90	0.005	0.010
16	0.010	0.005	120	0.010	0.010

APPENDIX F

POWER PLANT SITE IN SITU RESPIRATION TEST DATA

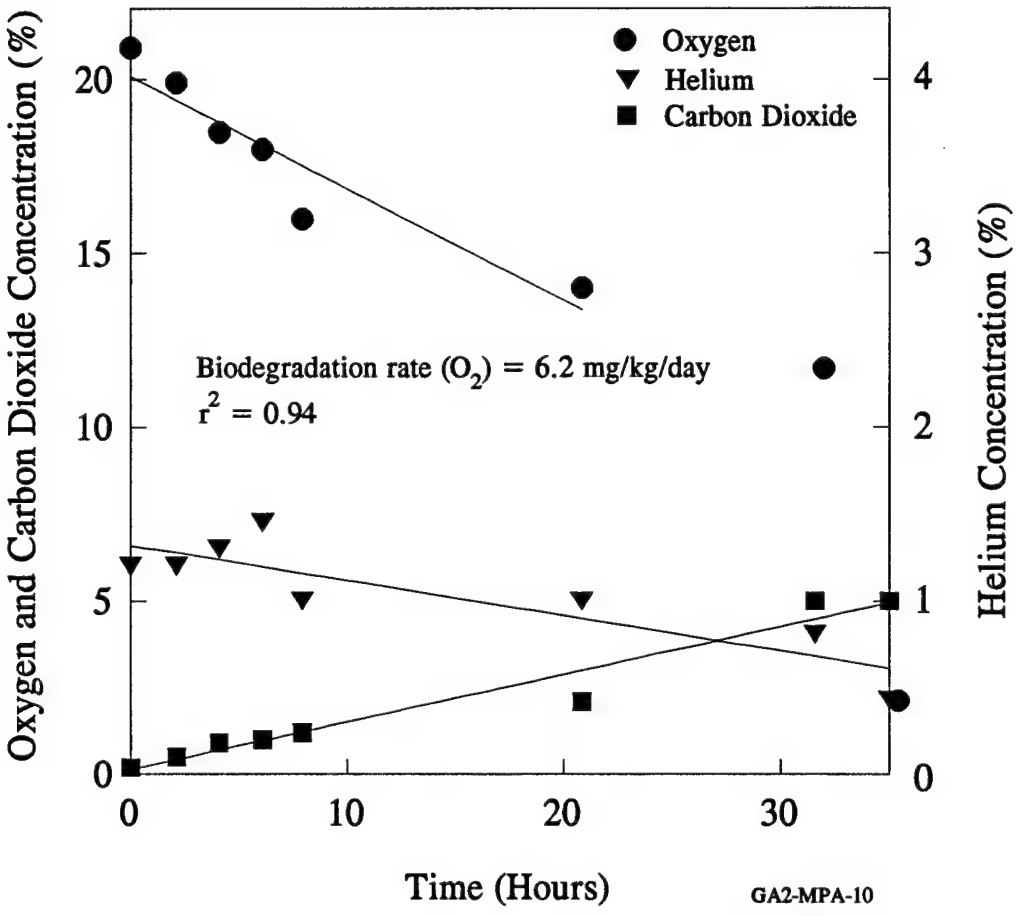

Figure F-1. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G2-MPA-10.0'

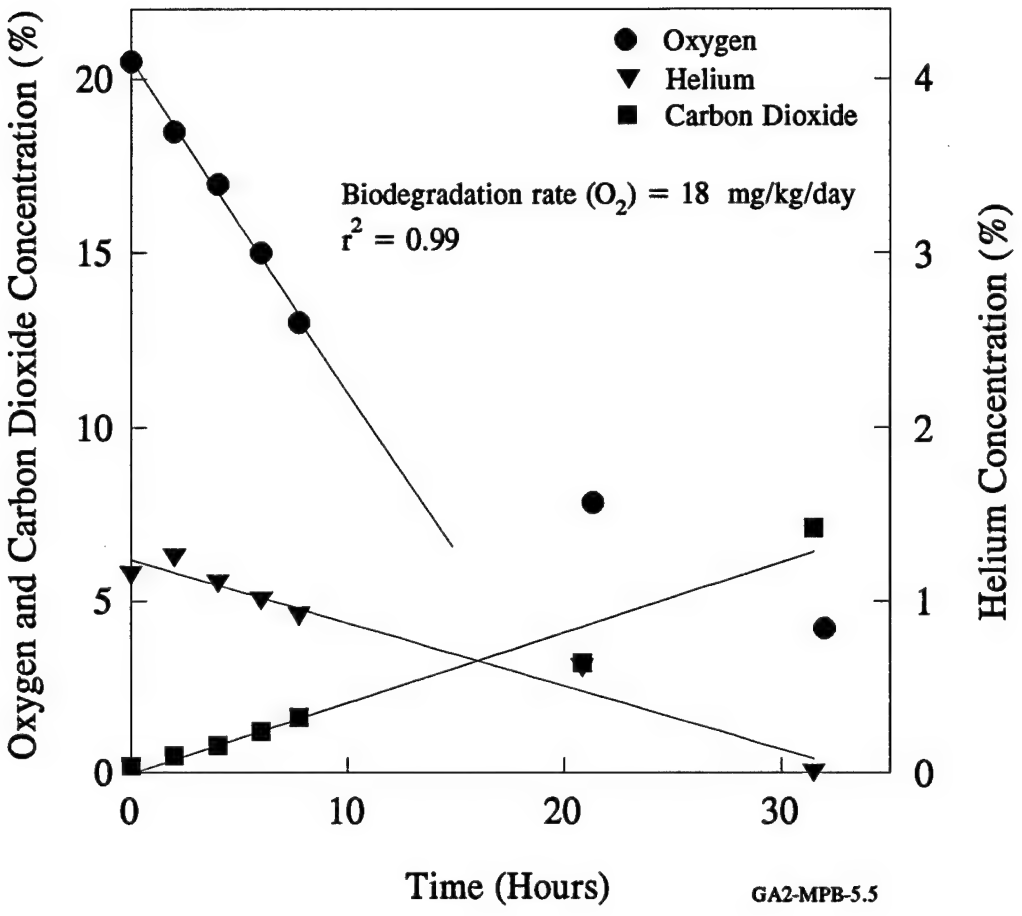

Figure F-2. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G2-MPB-5.5′

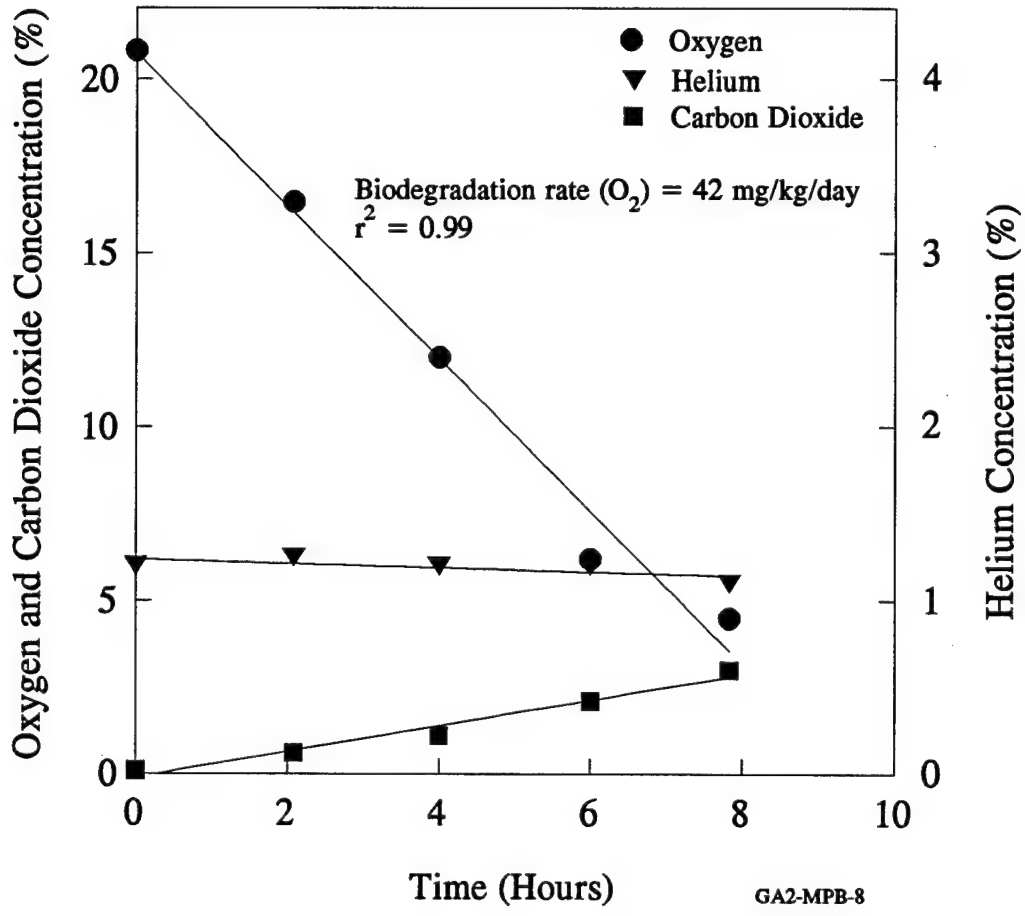

Figure F-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G2-MPB-8.0'

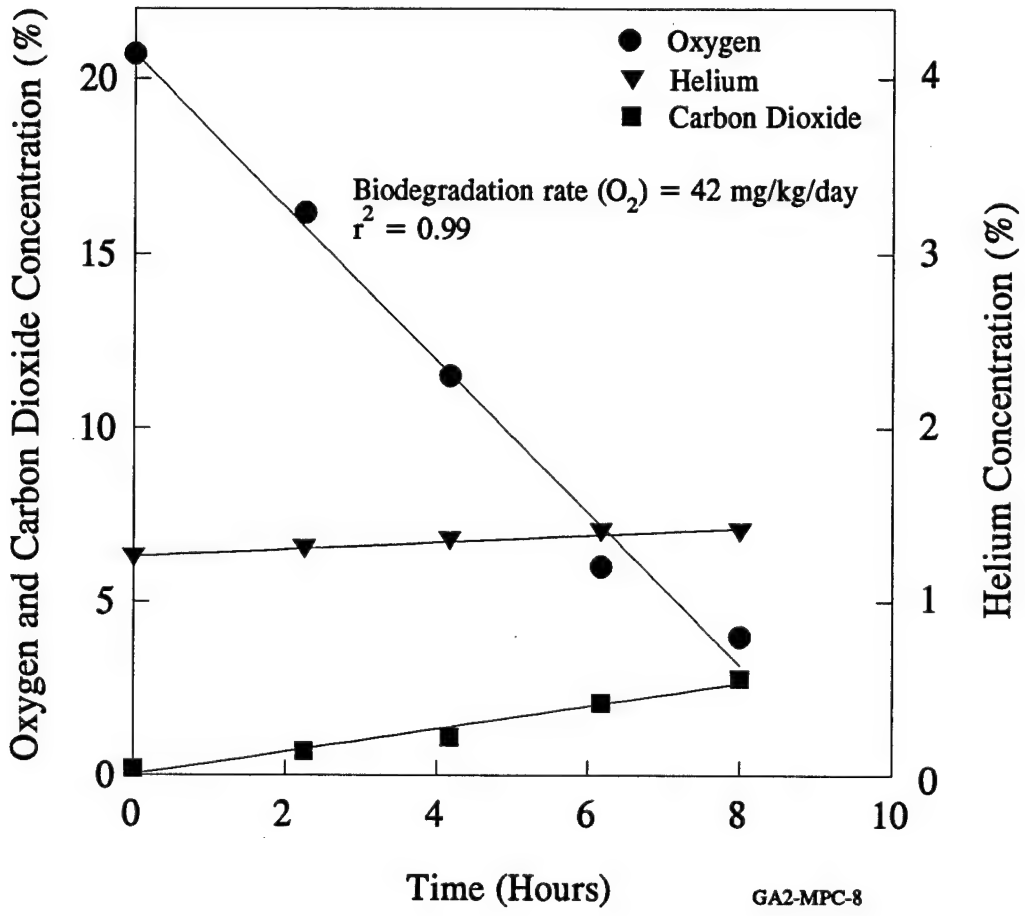

Figure F-4. **Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G2-MPC-8.0′**

APPENDIX G

MILLION GALLON HILL SITE SOIL GAS PERMEABILITY DATA

TABLE G-1. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G3-MPA

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	10.0′	20.0′	27.5′		10.0′	20.0′	27.5′
0	0	0	<0	18	.005	0	9.5
1	<0	0	4.0	20	0.005	0.01	9.7
2.1	0	0	5.5	22	0.005	0.005	9.8
3	0.005	0	7.0	24	0.005	0.005	9.9
4	0.01	0.005	7.5	26	0.005	0.01	10.0
5	0.01	0.01	7.9	28	0.005	0.01	10.0
6	0.01	0.005	8.0	30	0.005	0.015	10.0
7.1	0.01	0.005	8.4	33	0.01	0.013	10.2
8.2	0.01	0.01	8.5	36	0.01	0.015	10.5
9.2	0.01	0.01	8.8	39	0.01	0.015	10.5
10	0.01	0.005	9.0	50	0.005	0.005	10.2
12	0.01	0.005	9.0	60	0.015	0.01	10.5
14	0.005	0.005	9.2	90	0.005	0.01	10.5
16	0.005	0.005	9.5	120	0.01	0.005	10.5

TABLE G-2. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G3-MPB

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	10.0′	20.0′	27.5′		10.0′	20.0′	27.5′
0	0	0	0	31	0.066	0.80	1.0
1	<0	<0	<0	34	0.079	0.85	1.10
3	<0	<0	<0	37	0.078	0.85	1.15
5	0	0.09	0.10	40	0.080	0.87	1.17
7	0	0.25	0.30	44	0.094	0.87	1.20
9	0	0.30	0.36	46	0.094	0.90	1.25
11	0.02	0.35	0.45	49	0.086	0.90	1.20
13	0.04	0.45	0.55	52	0.086	0.90	1.20
15	0.05	0.50	0.65	56	0.086	0.95	1.25
17	0.05	0.55	0.75	57	0.086	0.94	1.20
20	0.056	0.65	0.85	59	0.084	0.94	1.25
22	0.057	0.70	0.90	75	0.084	0.94	1.20
25	0.07	0.75	0.95	90	0.083	0.94	1.20
29	0.069	0.77	0.96	120	0.083	0.94	1.20

TABLE G-3. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT G3-MPC

Time (min)	Pressure ("H_2O) by Depth		Time (min)	Pressure ("H_2O) by Depth	
	10.0′	20.0′		10.0′	20.0′
0	0	0	33	0	0.02
2	0	0	36	0	0.02
4	0	0	39	0	0.02
5	0	0	43	0	0.02
8	0	0	45	0	0.02
10	0	0	55	0	0.02
12	0	0	75	0	0.018
14	0	0	90	0	0.019
16	0	0	120	0	0.019
19	0	0			
22	0	0			
24	0	0.01			
27	0	0.015			
30	0	0.015			

APPENDIX H

MILLION GALLON HILL SITE IN SITU RESPIRATION TEST DATA

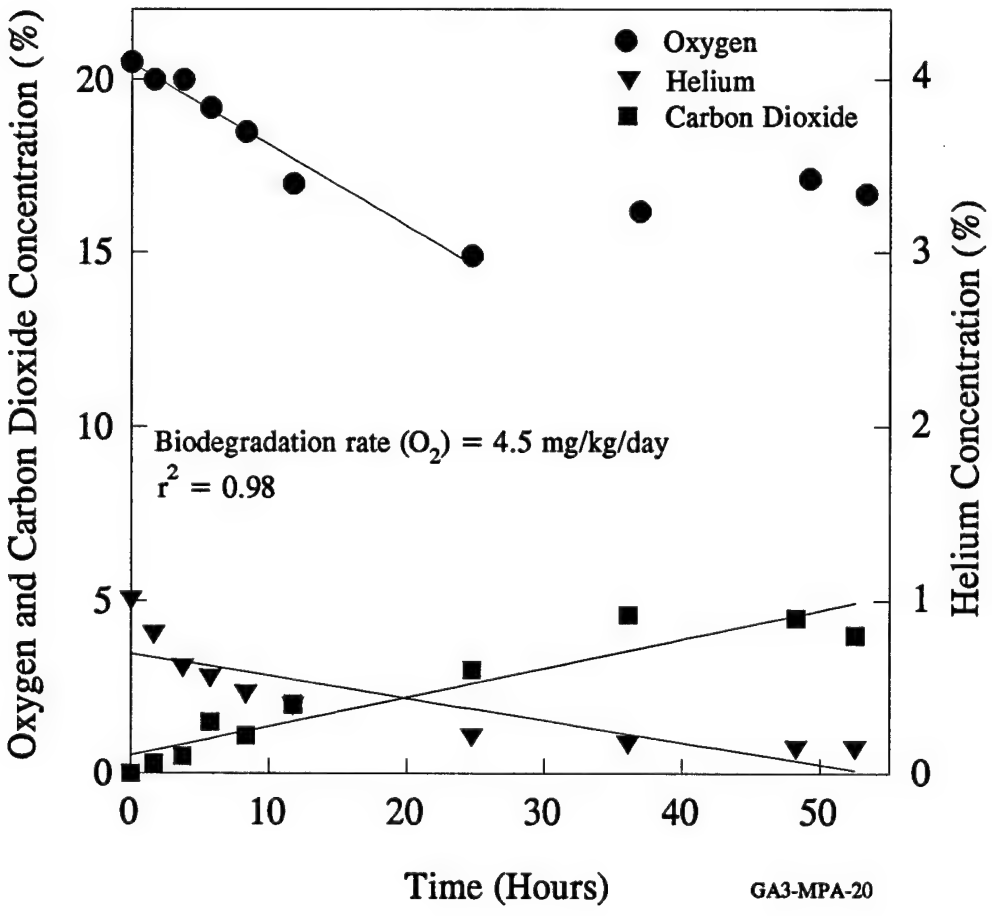

Figure H-1. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G3-MPA-20.0'

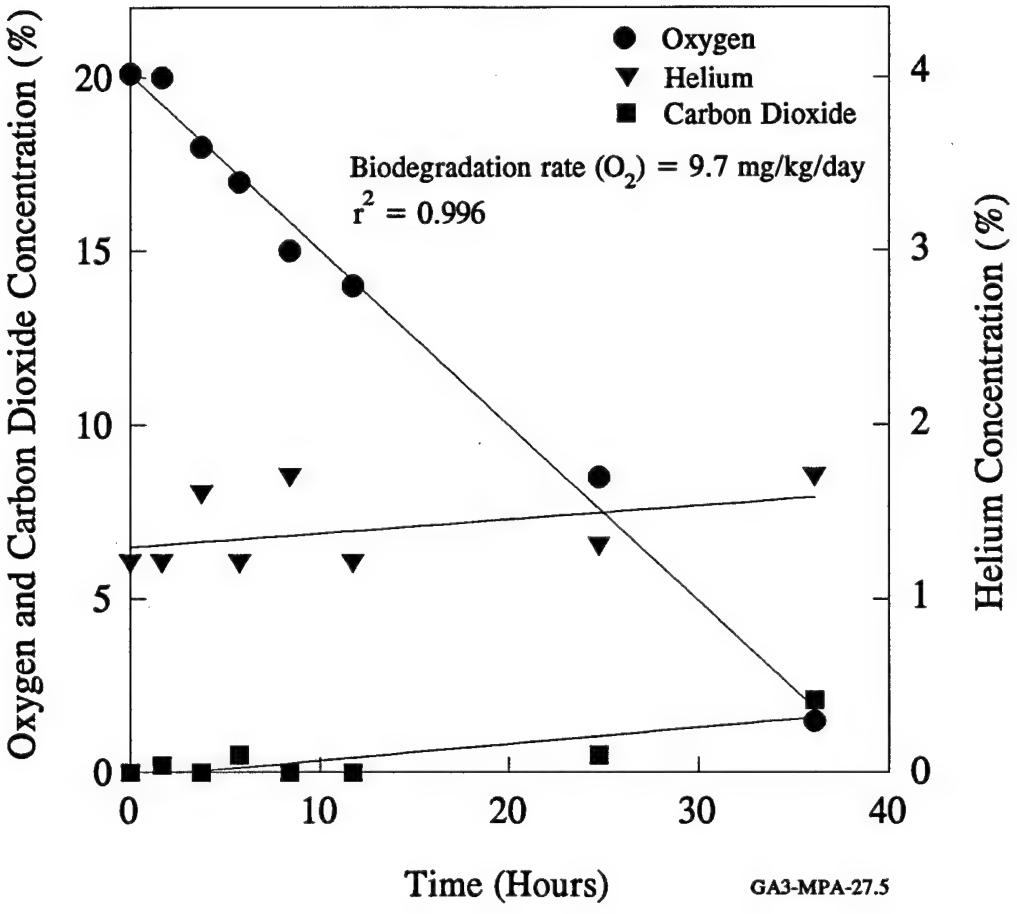

Figure H-2. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G3-MPA-27.5'

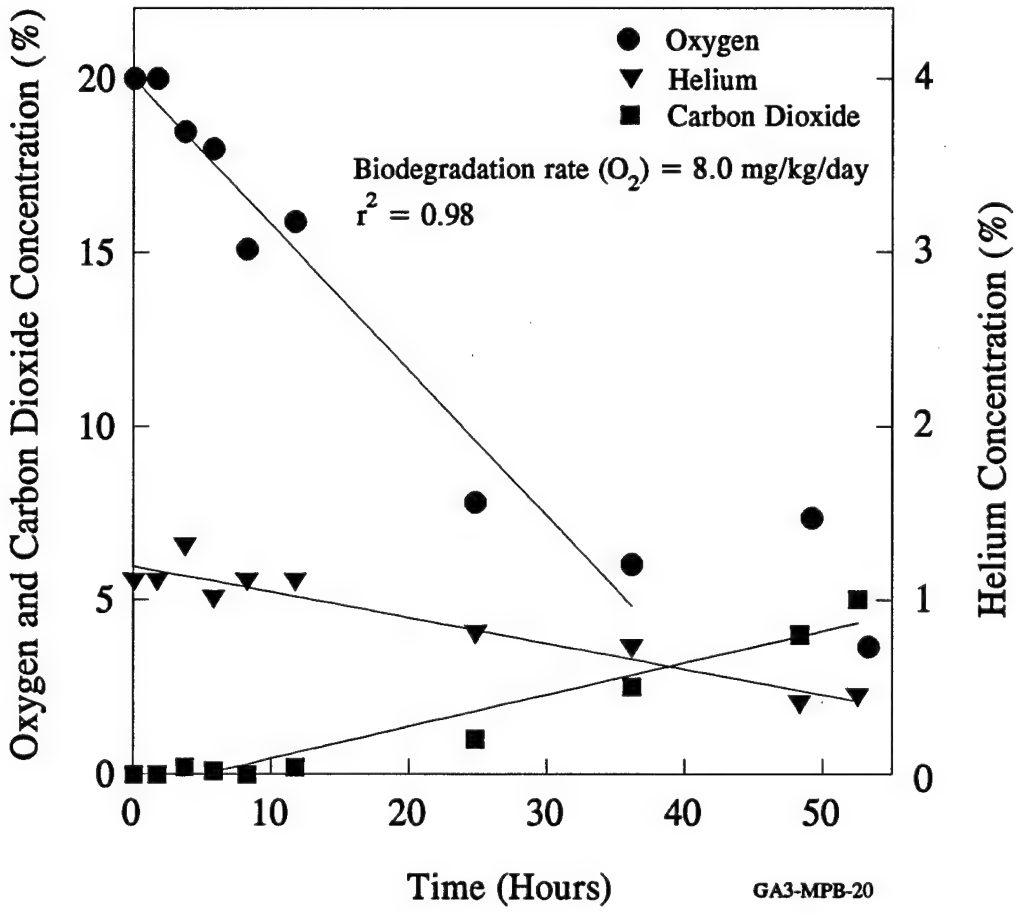

Figure H-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G3-MPB-20.0'

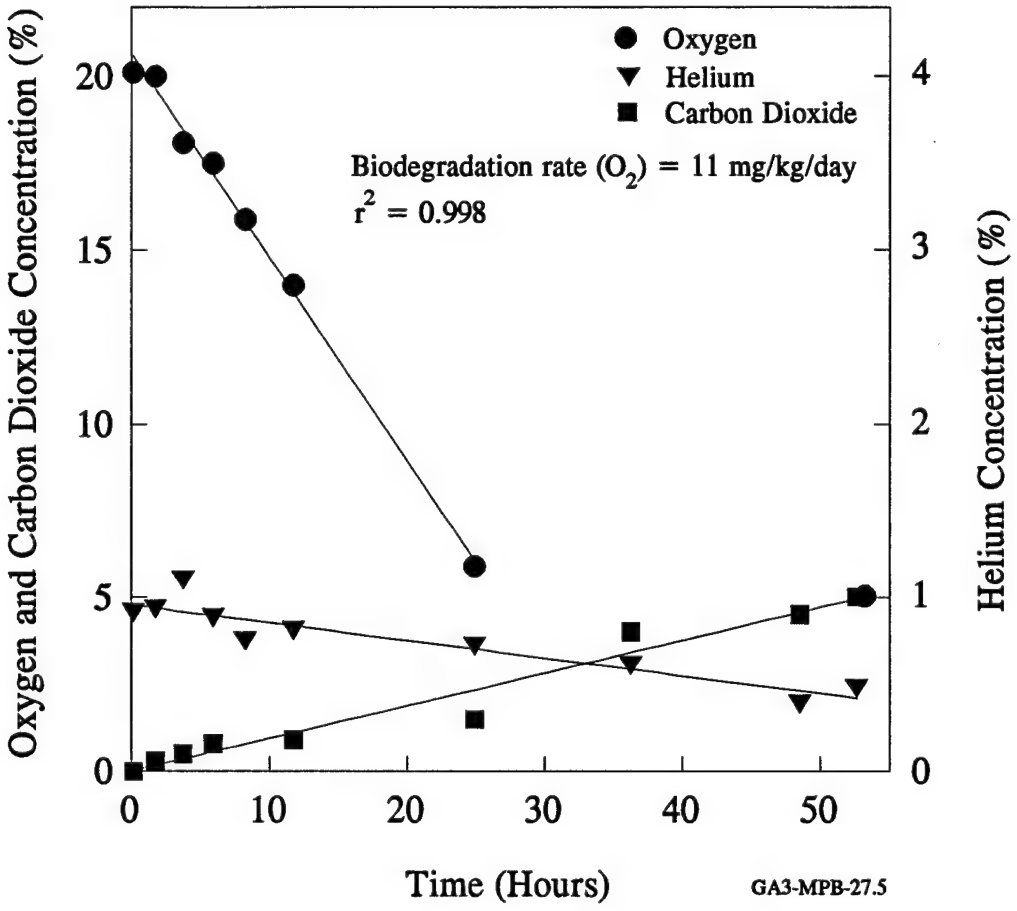

Figure H-4. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point G3-MPB-27.5′

APPENDIX I

CAMPION POL TANK SITE SOIL GAS PERMEABILITY DATA

TABLE I-1. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT CA-MPA

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	3.0′	5.0′	7.0′		3.0′	5.0′	7.0′
0	0	0	0	17	0.140	1.65	1.85
1	0.130	1.80	2.1	18	0.135	1.65	1.85
2	0.140	1.75	2.1	20	0.135	1.65	1.85
3	0.135	1.75	2.1	22	0.132	1.60	1.80
4	0.140	1.70	1.85	24	0.131	1.60	1.80
5	0.135	1.60	1.80	26	0.131	1.60	1.80
7	0.140	1.55	1.75	28	0.131	1.60	1.77
8	0.125	1.50	1.70	30	0.127	1.55	1.77
9	0.120	1.45	1.60	60	0.130	1.55	1.77
12	0.110	1.35	1.60	90	0.127	1.55	1.75
14	0.140	1.60	1.75				

TABLE I-2. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT CA-MPB

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	3.0′	5.0′	7.0′		3.0′	5.0′	7.0′
0	0	0	0	16	0.061	0.069	0.082
1	0.06	0.074	0.088	19	0.062	0.068	0.08
3	0.064	0.071	0.086	21	0.06	0.064	0.079
5	0.064	0.069	0.081	23	0.059	0.065	0.079
6	0.06	0.069	0.08	24	0.059	0.065	0.079
8	0.059	0.061	0.08	25	0.059	0.065	0.079
10	0.059	0.064	0.075	27	0.056	0.064	0.079
11	0.055	0.06	0.07	29	0.056	0.064	0.079
12	0.053	0.058	0.069	60	0.061	0.069	0.084
14	0.051	0.057	0.067	90	0.061	0.068	0.084

TABLE I-3. RESULTS OF SOIL GAS PERMEABILITY TEST AT MONITORING POINT CA-MPC

Time (min)	Pressure ($"H_2O$) by Depth			Time (min)	Pressure ($"H_2O$) by Depth		
	3.0′	5.0′	7.0′		3.0′	5.0′	7.0′
0	0	0	0	18	0.041	0.041	0.041
2	0.039	0.04	0.04	20	0.041	0.041	0.041
4	0.04	0.041	0.041	22	0.041	0.041	0.041
5	0.041	0.041	0.041	23	0.041	0.041	0.041
7	0.041	0.041	0.041	24	0.041	0.041	0.041
9	0.041	0.041	0.041	28	0.041	0.041	0.041
10	0.04	0.04	0.04	30	0.041	0.041	0.041
12	0.04	0.04	0.04	62	0.041	0.041	0.041
13	0.039	0.038	0.038	90	0.041	0.041	0.041
14	0.039	0.041	0.041				

APPENDIX J

CAMPION POL TANK SITE IN SITU RESPIRATION TEST DATA

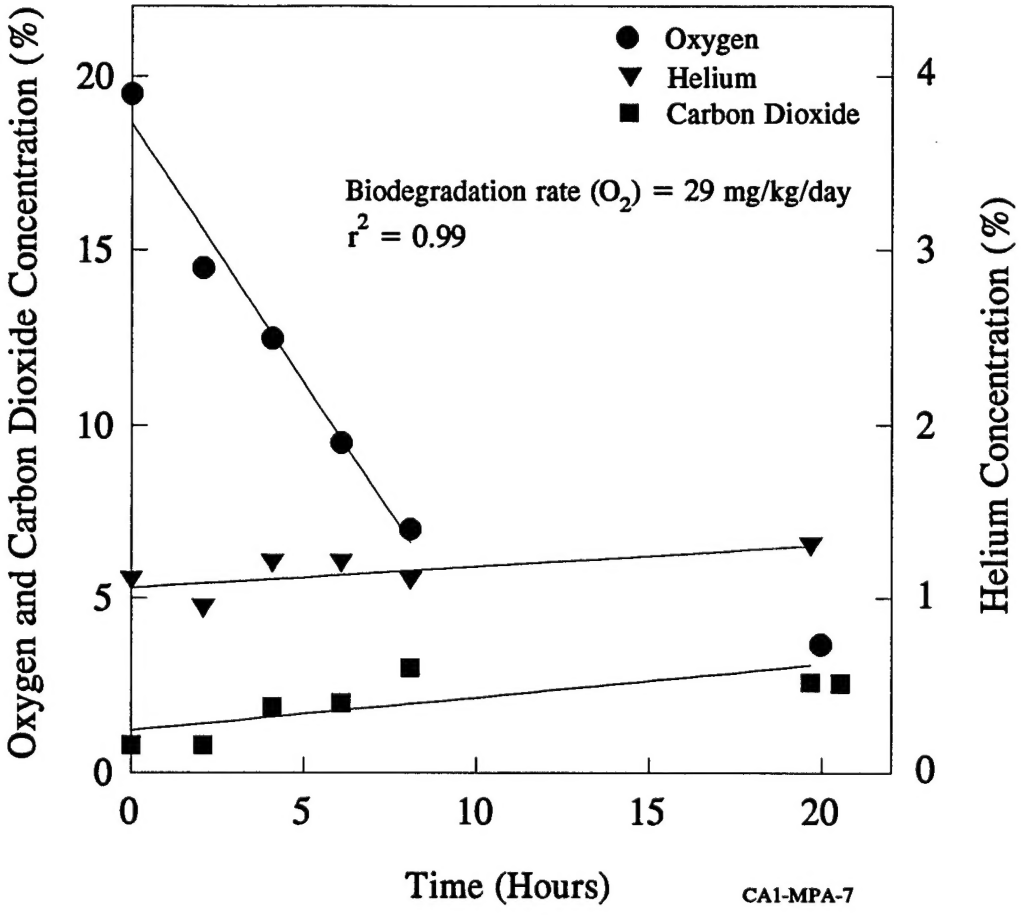

Figure J-1. **Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point C1-MPA-7.0'**

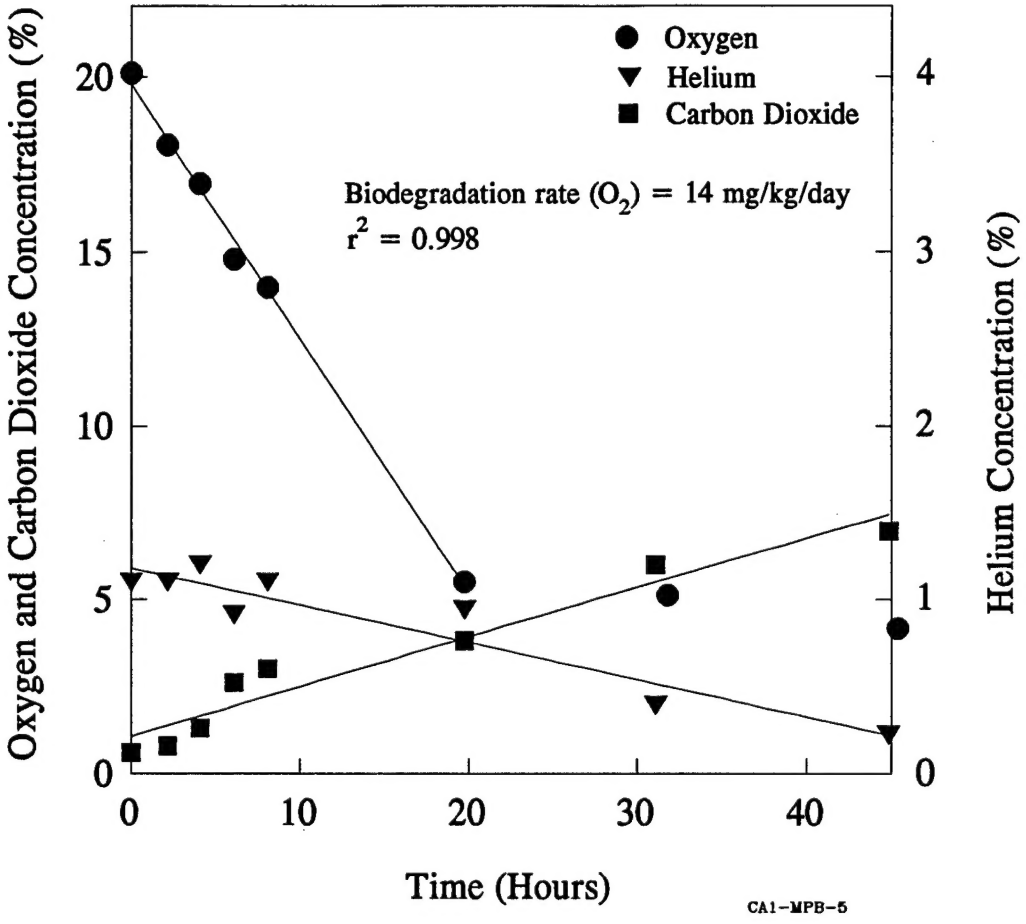

Figure J-2. **Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point C1-MPB-5.0′**

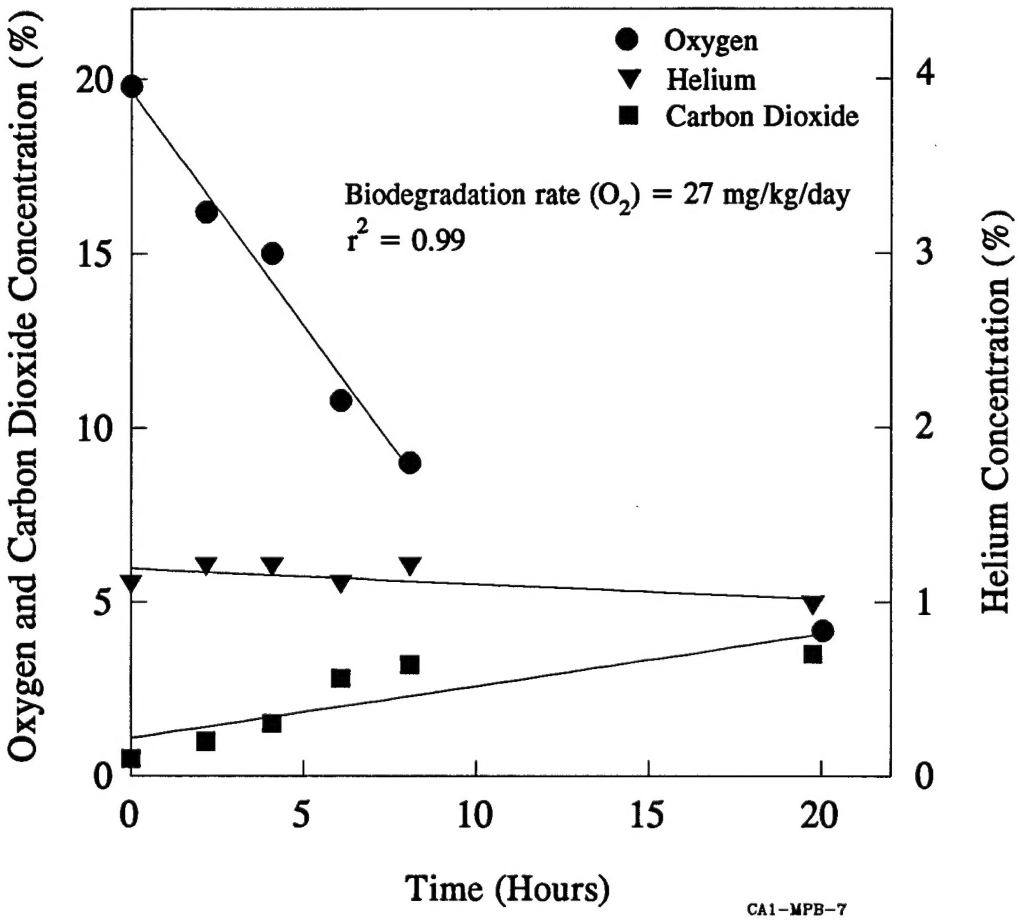

Figure J-3. **Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point C1-MPB-7.0′**

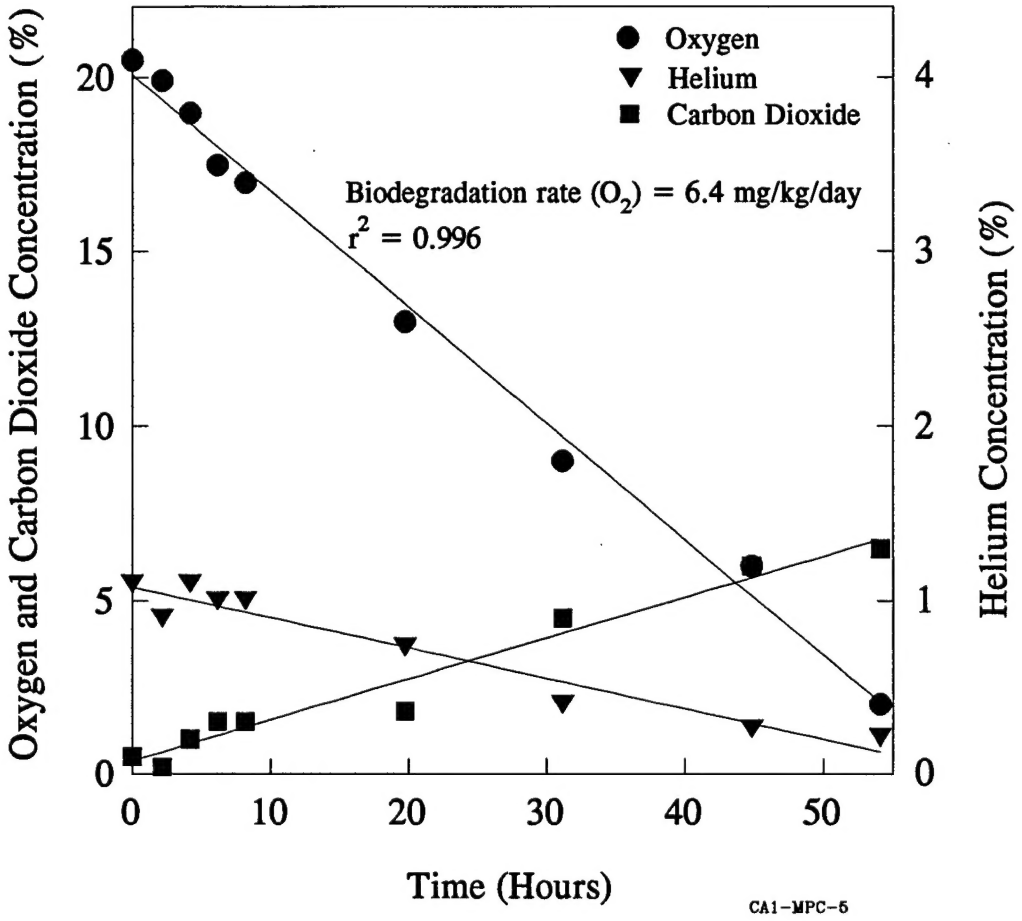

Figure J-4. **Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point C1-MPC-5.0'**